PRE-OPERATIVE EVALUATION

OF CHRONIC SUPPURATIVE OTITIS MEDIA

TUBOTYMPANIC DISEASE

OTOMICROSCOPY VERSUS

OTOENDOSCOPY:

A COMPARATIVE AND CORRELATIVE

STUDY

PRE-OPERATIVE EVALUATION OF CHRONIC SUPPURATIVE OTITIS MEDIA TUBOTYMPANIC DISEASE OTOMICROSCOPY VERSUS OTOENDOSCOPY: A COMPARATIVE AND CORRELATIVE STUDY

A dissertation submitted in part fulfillment of the requirement for the

M.S. Branch IV (Otorhinolaryngology) examination of

The Tamil Nadu Dr.M.G.R. Medical University, Chennai,

to be held in March 2007.

ACKNOWLEDGEMENT

I am grateful to Dr.Rupa Vedantam, Professor and Head, Department of Otorhinolaryngolgy, Head and Neck Surgery, Speech and Hearing, CMC Hospital, Vellore for her guidance and valuable advice in preparing this dissertation.

I wish to convey my deepest thanks and gratitude to Dr.Anand Job, Professor, Department of Otorhinolaryngolgy, Head and Neck Surgery, Speech and Hearing, CMC Hospital, Vellore for being my guide and mentor, his constant support and encouragement in conducting this study.

I am very thankful to Dr.Arif ali.K, Lecturer, Department of Otorhinolaryngolgy, Head and Neck Surgery, Speech and Hearing, CMC Hospital, Vellore for being my Co-investigator and for all his help in completing this dissertation.

I am grateful to Dr.K.G.Selvaraj, Department of Biostatistics, CMC, Vellore for his able guidance and help in the statistical analysis of this study.

Last and not at all the least I wish to thank Mr.Jamaludeen for his help in preparing the manuscript.

CERTIFICATE

This is to certify that the work presented in this dissertation, in partial fulfillment of the Degree of **MS Branch IV (ENT)** examination of **The Tamilnadu Dr.M.G.R**. **Medical university, Chennai** entitled **"PRE-OPERATIVE EVALUATION OF CHRONIC SUPPURATIVE OTITIS MEDIA-TUBOTYMPANIC DISEASE, OTOMICROSCOPY VERSUS OTOENDOSCOPY: A COMPARATIVE AND CORRELATIVE STUDY"** is the bonafide original work of **Dr. Z.Sarin Kaushal,** post graduate student in MS (ENT).It was carried out and prepared under my overall guidance and supervision in the Department of Otorhinolaryngology, Head and Neck Surgery, Speech and Hearing, Christian Medical College & Hospital, Vellore.

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INTRODUCTION

Chronic Suppurative Otitis Media, tubotympanic disease remains one of the commonest conditions in India that an ENT surgeon is faced with in his routine practice. Though life threatening complications associated with this condition are rare, other conditions such as recurrent discharge despite treatment, residual perforation, worsening hearing, graft failure, etc are not uncommon. For these reasons complete and meticulous evaluation of the patient is very important.

The introduction of the binocular operating microscope was a landmark event in the development of modern otology, and it clearly changed the scope and character of ear surgery. Despite continuous technical improvements, the basic optical principles, and their limitations have stayed the same over the last three decades [1].

With the introduction of the endoscope into other branches of surgery, there have been attempts at its utilization in otology. The diagnostic, mostly photographic, role of the endoscope for examining the tympanic membrane and the ear canal has been widely publicized [2]. Transtympanic middle ear endoscopy was initially reported by Nomura and Takahashi et al [3]. Poe and Bottri described transtympanic endoscopy for the confirmation of perilymphatic fistula, as well as the identification of other middle ear disorders [4]. McKennan described second look endoscopic inspection of mastoid cavities through a small postauricular incision [5]. Thomasin et al reported operative ear endoscopy for mastoid cavities and designed an instrument set to be used in these settings [6]. Tarabichi reported that endoscopes offer greatest technical advantage in tympanoplasty and cholesteatoma surgery [1].

Other investigators looked at the role of the endoscope in neurotologic procedures. However most of these studies are done in ear disease with cholesteatoma. Very few studies have been documented so far to demonstrate the use of otoendoscopy in Chronic Suppurative Otitis Media-tubotympanic disease in evaluating the pre-operative health of the middle ear and thus to determine the cause of the disease for e.g. eustachian tube dysfunction, etc and in assessing the possible outcome of the surgery for e.g. hearing improvement with ossicular discontinuity. The need for a complete middle ear examination especially in the areas of eustachian tube orifice, sinus tympani, ossicular chain, etc is great, but is often not possible due to the limitations of a microscope. The need for magnification in otologic surgery and the small diameter of the ear canal necessitate a careful consideration of the optical and physical properties of the different rigid endoscopes. The rod lens scope, first developed by Hopkins uses rod-shaped glass lenses in the relay system. The lenses are thick and the air spaces are small. The rod lens provides for a wider viewing angle and exceptional resolution and brightness. Most sinus endoscopes and smaller endoscopes belong in this category. The wide angled 0^0 and 30^0 endoscopes provide excellent visualization of structures such as ear canal [1,7]. The 70^0 endoscopes are excellent to visualize sinus tympanum [1,6]. The 45^0 endoscopes can be used to visualize the ossicular chain.

The endoscopic view usually includes the whole tympanic ring and ear canal at the same time. It is not defined by the narrowest segment of the ear canal. This provides a complete view of the middle ear space, tympanic membrane, and ear canal without the need for continuous repositioning of the patient's head and the microscope [1]. The impact of the endoscope on middle ear surgery will have to be considered on the basis of the surgical task contemplated and the importance of the advantages and disadvantages in specific situations.

For inspection of the middle ear space, the endoscope is a superior instrument. The advantages include the ability for pre/per-operative evaluation of the facial recess, sinus tympani, hypotympanum, attic, and the anterior part of the tympanic cavity including eustachian tube area, protympanum etc.

AIMS AND OBJECTIVES

To determine the usefulness of rigid endoscopy in pre-operative assessment of the middle ear in Chronic Suppurative Otitis Media, Tubotympanic Disease

REVIEW OF LITERATURE

Anatomy and Embryology

Embryology of the ear [8,9]

Valsalva, in his classic treatise printed in Bologna in 1704, first divided the auditory organ into three parts: external, middle, and inner ear. Developmentally, the three primitive germ layers contribute in different ways to the various structures contained within these parts. Ectoderm contributes to the formation of the auricular, meatal, and tympanic membrane (outer epithelial portion) components of the external ear and to the membranous labyrinth of the inner ear. Mesoderm gives rise to the auricular cartilages and muscles of the external and middle ear, the tympanic cleft, the ossicles, the middle (fibrous) layer of the tympanic membrane, and the periotic labyrinth and otic capsule of the inner ear. Endoderm contributes only to middle ear development, giving rise to the tubotympanic air cell system from the eustachian tube orifice to the most distant mastoid air cells and to the inner (mucosal) layer of the tympanic membrane.

Developmental Interrelations

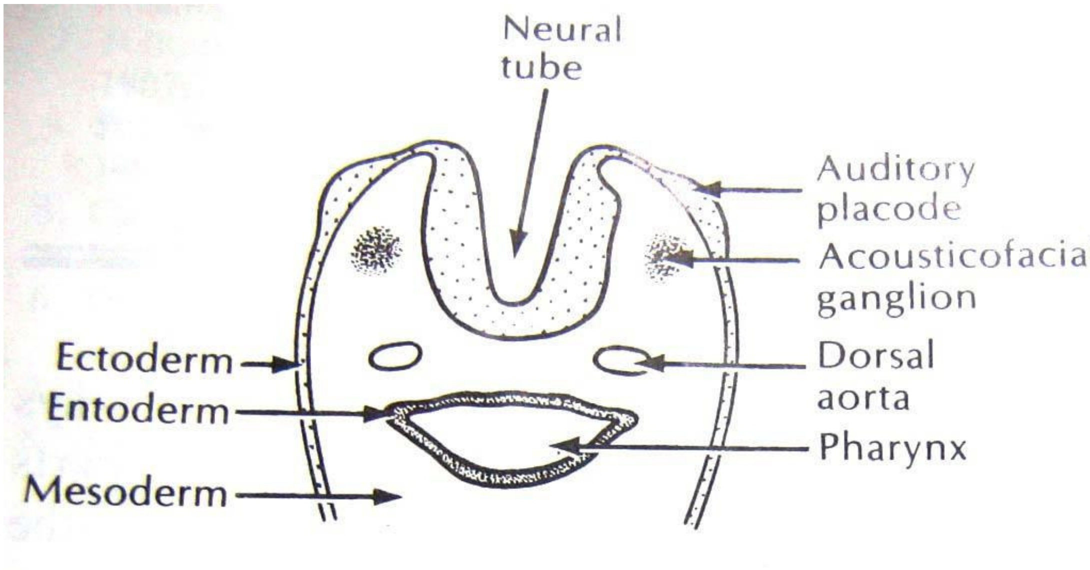
Throughout their development, the three divisions of the human ear maintain several important interrelations. At the end of the third week of gestation, the auditory placode appears as an ectodermal thickening adjacent to the neural tube and lateral to the acousticofacial ganglion. At this point the auditory placode, which will contribute to the formation of the inner ear, and the primitive gut endoderm, which will form the middle ear cavity, are growing simultaneously.

The auditory placode invaginates, forming the otic pit. It soon closes to form the otocyst (otic vesicle). Simultaneously, the first branchial groove begins to develop, with condensation of mesenchyme between the groove and the entodermal pouch. This mesenchymal condensation represents the anlage of future middle ear components, including the ossicles.

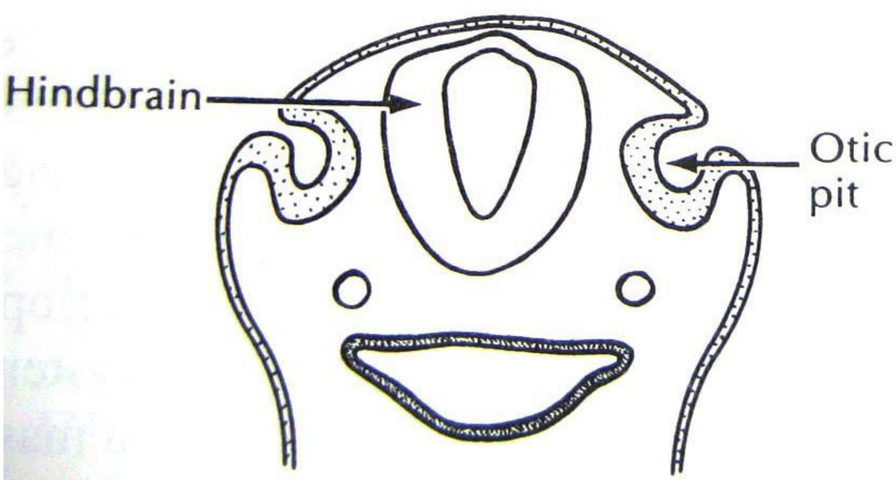
The first branchial arch (mandibular), the second branchial arch (hyoid), and the maxillary processes develop at the same time that the otocyst and acousticofacial ganglion initiate the formation of the components of the membranous labyrinth. By the sixth week the hillock formations destined for the development of the auricle have appeared.

Development of the External Ear

The auricle develops around the first branchial grove from the six hillocks of Hiss, during the third fetal month. The tragus develops from the first (mandibular) arch and the rest of the auricle from the remaining five hillocks, which are of second (hyoid) arch origin. The branchial groove invaginates to meet the primitive entodermal pharyngeal pouch, but this ectodermal-endodermal apposition is encroached by superior and inferior mesodermal elements that rapidly separate this union. A solid core of epithelial cells, termed the meatal plate, grows toward the entodermal pharyngeal tube anlage.



DEVELOPMENT OF HUMAN EAR



Medial mesodermal elements begin to ossify during the fourth to fifth month to form the tympanic ring (annulus) for tympanic membrane support. However, it is not until the fifth to sixth fetal month that the solid ectodermal epithelial core (tympanic plate) begins dividing to form the lateral tympanic membrane epithelium and the skin of the bony external auditory canal, which arise simultaneously from the tympanic ring.

Development of the Middle Ear

As the first (ectodermal) branchial groove invaginates to approach the primitive entodermal tubotympanic recess, mesodermal aggregations appear above and below to separate the primitive junction. Tympanic membrane and middle ear structures will develop from them, including ossicles, muscles, and tendons. The first pharyngeal pouch, which is lined by endoderm, expands to form the eustachian tube and middle ear cavity. As noted earlier, each of the three germ layers contributes to formation of the tympanic membrane.

The origin of the ossicles is complex. It is thought that the superior portion of incus and malleus (forming the incudomalleal joint) arise from the first (mandibular) arch (Meckel's cartilage). The lower aspects of the incus and malleus and the arch of the stapes arise from the second (hyoid) arch (Reichert's cartilage). Initially the stapes is annular in appearance (chondral annulet), but by the fourth fetal month it is assuming a more stirrup like form. The stapes footplate has a dual origin, with the lateral (tympanic) portion arising from the hyoid arch and the medial (vestibular) portion from the otic capsule. At approximately the fourth fetal month, the ossicles begin to ossify.

As the ossicles develop and assume their positions within the mesotympanum, the eustachian tube remains an air-filled space, whereas tympanic mesenchyme still occupies the region of the future middle ear. Occasionally, mesenchyme may persist in the infant middle ear.

The endodermal primordium of the eustachian tube provides the ciliated epithelial lining for the tympanic cavity, attic, antrum, and entire mastoid air cell system. Errors in first pharyngeal pouch differentiation may be responsible for maldevelopments of the eustachian tube, middle ear, and mastoid.

ANATOMY OF THE MIDDLE EAR [8,10]

Tympanic Membrane

The tympanic membrane (eardrum) is a multilayered, cone-shaped structure measuring approximately 9 mm in diameter, with radii varying from 4 to 5 mm. It is anchored to the bony tympanic ring, and it separates the external and middle ear. The tympanic membrane is attached to the malleus handle (manubrium) between the short (lateral) process and umbo of that ossicle. The umbo is the medial apex of the tympanic membrane

The major portion of the tympanic membrane is the pars tensa, which is separated from the superior portion known as pars flaccida (Shrapnell's membrane) by the anterior and posterior malleal plicae (folds), which extend from the malleal short process to the annular rim. Medial to the pars flaccida is

Prussak's space, a common area for primary cholesteatoma extension. The pars tensa is normally translucent, occasionally permitting visualization of the long process of the incus and the incudostapedial joint in its posterosuperior quadrant.

The tympanic membrane is approximately 0.1 mm thick and is constituted by a lateral (squamous), middle (fibrous), and a medial (mucosal) layer. In the pars tensa the collagenous fibers of the middle layer are plentiful and organized both radially and circumferentially, whereas the fibers in the pars flaccida are less abundant and poorly organized. A thickening of the fibers at the limits of the pars tensa constitutes the fibrous annulus, an element lacking in the pars flaccida. These structural differences are responsible for the characteristic tightness of the pars tensa and the drape like quality of the pars flaccida.

The Ossicles

The malleus (weight ±23 mg) consists of a head, neck, and three processes: the manubrium into which the tympanic membrane is inserted, the anterior process (usually vestigial), and the lateral (short) process. The malleal head, which occupies a major portion of the epitympanum (attic), is supported by a complex system of ligaments.

The incus consists of a body with a long and a short process. The body articulates with the head of the malleus, forming the incudomalleal joint. The short process projects into the posteroinferior portion of the epitympanic recess. In this position it can be seen from a mastoid view as a landmark in mastoidectomy. The long process descends in a posterior direction parallel to the malleal manubrium and, turning medially, ends at the lenticular process, which articulates with the head (capitulum) of the stapes to form the incudostapedial joint.

The stapes is the smallest bone in the body. It consists of a head (capitulum), which articulates with the incus at the incudostapedial joint, a neck, two crura or legs, and the footplate. The head, neck, and crura form the stapedial arch, which is attached to the footplate. The head and neck consist of marrow bone, whereas the crura consist of partly hollowed, semicylindrical shells of cortical bone. The crura form the boundaries of the obturator (stapedial) artery, which occupies this space in fetal life. Rarely, it may persist into adulthood, producing conductive hearing loss and tinnitus.

The tensor tympani muscle attaches to the proximal manubrium (or neck) of the malleus and maintains a variable tension on the tympanic membrane. In addition, there are superior, anterior, posterior, and mediolateral suspensory ligaments attaching to the malleus and incus. The stapedius muscle attaches to the head of the stapes.

The Middle Ear Cleft

The middle ear (tympanum, tympanic cavity) is an air containing space, contiguous anteroinferiorly with the eustachian tube and nasopharynx and posteriorly with the air cell system of the mastoid and petrous portions of the temporal bone. The middle ear is lined with a mucous membrane that is best described as modified respiratory mucosa. Cell types include ciliated cells, nonciliated cells with and without secretory granules, and goblet cells. Ciliated columnar epithelium predominates in the hypotympanum, near the eustachian tube orifice, and in the eustachian tube proper.

The middle ear cleft is formed by four walls, a roof, and a floor. The tegmen tympani form the roof and the jugular bulb the floor. The posterior wall of the middle ear contains a number of anatomic structures including the pyramidal eminence, facial recess, and sinus tympani. Anteriorly, the major landmarks are the semicanal for the tensor tympani muscle, the wall of the internal carotid artery, and the eustachian tube orifice. The predominant structure of the medial wall of the middle ear is the basal turn of the cochlea (promontory); other important anatomic features include the oval and round windows, the fallopian canal for the horizontal segment of the facial nerve, and the cochleariform process from which the tensor tympani tendon emerges. The tympanic membrane forms the lateral wall of the middle ear cleft. The middle ear also can be divided topographically into the epitympanum, mesotympanum, and hypotympanum.

The epitympanum (attic) houses the incudomalleal joint, the head of the malleus, and the body of the incus with their suspensory ligaments. The epitympanic air space is in direct continuity anteriorly with the zygomatic air cell system and is bounded superiorly by the tegmen tympani, a thin bony plate separating the middle ear from the middle cranial fossa. Of particular note is the anterior epitympanic recess (supratubal recess). This pneumatized area lies anterior to the head of the malleus. The ossicular heads partially obscure this recess from inspection during surgical procedures, and for this reason complete removal of disease, particularly cholesteatoma, may be problematic. The epitympanic air space communicates posteriorly through the aditus with the antrum, the primary cell of the mastoid air cell system. The medial wall of the epitympanum contains the anterior portions of the superior and lateral semicircular canals, and the horizontal segment of the facial canal. Laterally, it is bounded by the pars flaccida and the posterosuperior edge of the ear canal, or scutum. The meso tympanum is the largest part of the middle ear. It is bound laterally by the pars tensa and contains the neck and manubrium of the malleus, the long process of the incus, the stapes and oval window, and the round window niche. The horizontal portion of the facial canal forms its superomedial boundary. The oval window niche is occupied by the stapedial footplate and its annular ligament, providing a sealed but mobile communication between the middle ear and the vestibule. The cochlear promontory of the otic capsule is a rounded, smooth, bony surface forming one-third of the medial wall of the mesotympanum. It separates the oval window from the round window niche. The inferior portion of the promontory is the lower limit of the mesotympanum. The anterior portion of the mesotympanum joins with the anterior epitympanum to form the protympanum (bony eustachian tube opening), which communicates with the cartilaginous eustachian tube.

Along the posterior wall of the mesotympanum is the sinus tympani, a pneumatized recess that is bounded laterally by the mastoid segment of the facial nerve. This recess is of varying size and is of clinical significance in surgery for chronic otitis media and cholesteatoma because of the difficulty in removing disease from its depths. Lateral to the mastoid segment of the facial nerve is another pneumatized space, the facial recess. This space is important surgically, as it provides an access route from the mastoid into the mesotympanum. The facial recess is bounded laterally by the chorda tympani nerve and superiorly by the fossa incudis .

The hypotympanum is the lowest level of the middle ear space, and its floor is the dome of the jugular bulb. It communicates with the hypotympanic and retrofacial air cells anteriorly and posteriorly. The round window niche is a depression located inferoposterior to the promontory. The round window membrane, despite its name, is slightly elliptical in shape. It inserts in the anterosuperior portion of the niche. It is in medial contact with the scala tympani and in close proximity to the labyrinthine opening of the cochlear aqueduct.

Structures within the Middle Ear

The facial nerve is derived from the second branchial arch. It contains efferent fibers that innervate the facial muscles, the stylohyoid muscle, the posterior belly of the digastric muscle, and the stapedius muscle. It also contains preganglionic parasympathetic fibers that innervate the lacrimal gland, seromucous glands of the nasal cavity, and the submandibular and sublingual glands. Taste from the anterior two-thirds of the tongue is carried via afferent fibers within the facial nerve.

The facial nerve exits the pons, crosses the cerebellopontine angle, and enters the internal auditory canal with the vestibulocochlear nerve. The labyrinthine segment of the facial nerve is located between the lateral end of the internal auditory canal and the geniculate ganglion. At the geniculate ganglion, the nerve turns posteriorly (first or anterior genu) and enters the upper mesotympanum. This horizontal or tympanic segment courses just superior to the oval window and then turns inferiorly near the horizontal semicircular canal. This second bend is termed the posterior or second genu. At this bend, the nerve enters the mastoid air cell system and is termed the vertical or mastoid segment. The nerve finally emerges into the parotid space through the stylomastoid foramen. From the lateral end (fundus) of the internal auditory canal to the stylomastoid foramen, the nerve is encased within the bony fallopian canal.

The mesotympanum contains two muscles. The stapedius muscle arises from the pyramidal eminence located just inferior to the lateral genu of the facial nerve and from a portion of the proximal mastoid segment of the fallopian canal. It attaches to the neck of the stapes and is innervated by the facial nerve. Contraction of this muscle limits movement of the stapes and is the basis for acoustic reflex testing. The tensor tympani muscle is approximately 2 cm in length and arises in part from the cartilaginous portion of the eustachian tube and in part from a semicanal parallel to the eustachian tube. It courses posteriorly to a bony eminence, the cochleariform process, which overlies the tympanic portion of the fallopian canal. At this point, its tendon makes a right angle turn laterally to insert on the base of the manubrium of the malleus near its neck. The tensor tympani muscle is innervated by the mandibular branch of the trigeminal nerve. Contraction of this muscle causes the manubrium to move medially, tightening the tympanic membrane.

The eustachian tube is a 3.5-cm long, part bony and part cartilaginous, tube that connects the nasopharynx with the middle ear. Its upper (tympanic) orifice lies within the mesotympanum in a spacious bony channel, the protympanum, arising high on the anteromedial wall of the tympanic cavity. The tympanic portion of the eustachian tube is bony and measures approximately 10 mm in length and is shaped like a cone pointing infero-laterally. At the apex of the cone is the isthmus of the eustachian tube, its most narrow portion. Close to the cartilaginous portion the eustachian tube is oval in shape and approximately 3 mm high and 1.5 mm wide. Inferior to its isthmus the cartilaginous portion is approximately 2.5 mm in length and slit like. Medially, it opens onto the lateral wall of the pharynx, near the lateral pharyngeal recess (fossa of Rosenmuller). Superomedially, it is surrounded by a C-shaped cartilage, to which are attached two muscles, the tensor palatini, laterally, and the levator palatini, medially. Unlike the osseus portion of the eustachian tube, which remains open, the cartilaginous portion usually is closed because of the incomplete cartilage ring.

Medial to the osseous portion of the eustachian tube is the carotid canal. The carotid canal forms the anterior boundary of the tympanic cavity and often is associated with air cells. Through this canal traverses the internal carotid artery and associated venous and neural plexuses.

Mechanism of Hearing

Any vibrating object causes waves of compression and rarefaction and is capable of producing sound. In the air, at 20° C and at sea level, sound travels at a speed of 344 meters (1120 feet) per second. It travels faster in liquids and solids than in the air. Also, when sound energy has to pass from air to liquid medium, most of it is reflected because of the impedance offered by the liquid.

A sound signal in the environment is collected by the pinna, passes through external auditory canal and strikes the tympanic membrane. Vibrations of the tympanic membrane are transmitted to stapes footplate through a chain of ossicles coupled to the tympanic membrane. Movements of stapes footplate cause pressure changes in the labyrinthine fluids which move the basilar membrane. This stimulates the hair cells of the organ of corti. It is these hair cells which act as transducers and convert the mechanical energy into electrical impulses which travel along the auditory nerve. Thus, the mechanism of hearing can be broadly divided into:

1. Mechanical conduction of sound (conductive apparatus).
2. Transduction of mechanical energy to electrical impulses (sensory system of cochlea).
3. Conduction of electrical impulses to the brain (neural pathways).

1. Conduction of Sound

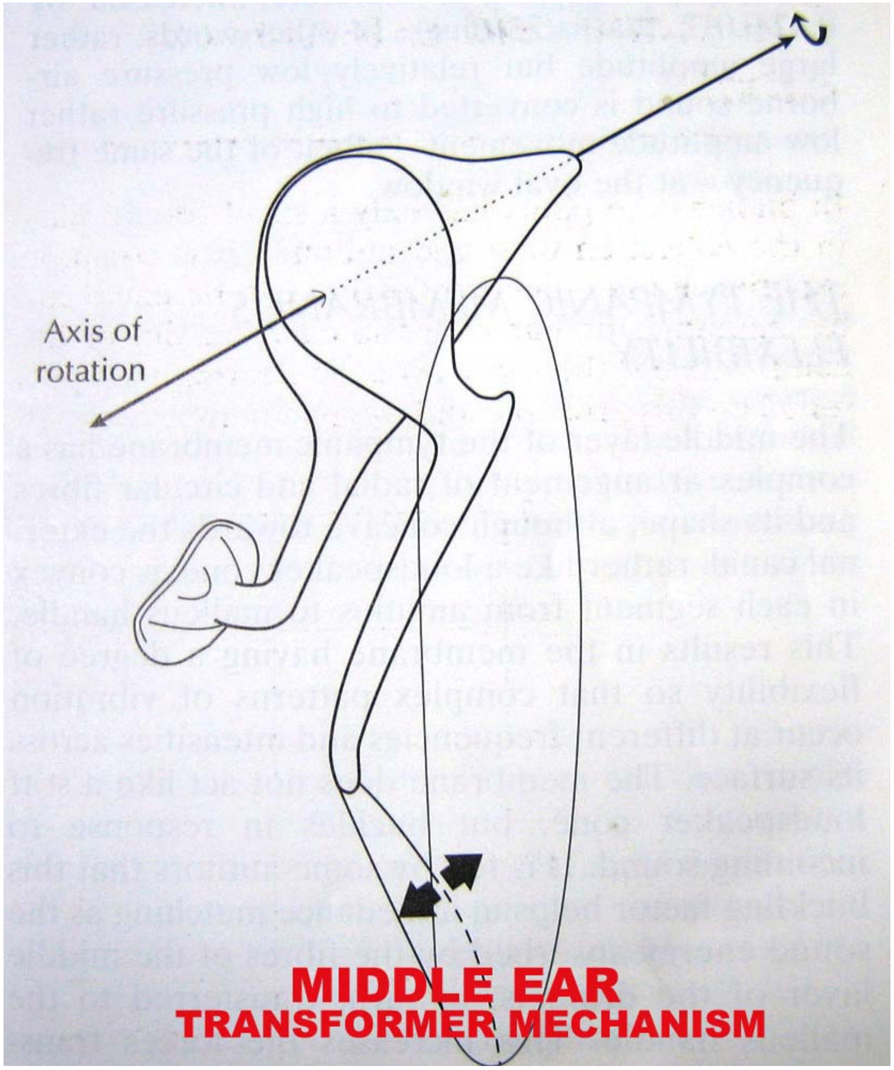
A person under water cannot hear any sound made in the air because 99.9% of the sound energy is reflected away from the surface of water because of the impedance offered by it. A similar situation exists in the ear when air-conducted sound has to travel to cochlear fluids. Nature has compensated for this loss of sound energy by interposing the middle ear which converts sound of greater amplitude, but lesser force, to that of lesser amplitude and greater force. This function of the middle ear is called impedance matching mechanism or the transformer action

It is accomplished by:

(a) Lever action of the ossicles. Handle of malleus is 1.3 times longer than long process of the incus, providing a mechanical advantage of 1.3.

(b) Hydraulic action of tympanic membrane.

The area of tympanic membrane is much larger than the area of stapes footplate, the average ratio between the two being 21:1. As the effective vibratory area of tympanic membrane is only two-thirds, the


Axis of rotation
MIDDLE EAR
TRANSFORMER MECHANISM

effective areal ratio is reduced to 14:1, and this is the mechanical advantage provided by the tympanic membrane.

The product of areal ratio and lever action of ossicles is 18:1.

According to some workers out of a total of 90 mm^2 area of human tympanic membrane, only 55 mm^2 is functional and given the area of stapes footplate (3.2 mm^2), the areal ratio is 17:1.

(c) Curved membrane effect.

Movements of tympanic membrane are more at the periphery than at the centre where malleus handle is attached. This too provides some leverage.

Phase differential between oval and round window - Sound waves striking the tympanic membrane do not reach the oval and round windows simultaneously. There is a preferential pathway to the oval window because of the ossicular chain. Thus, when oval window is receiving wave of compression, the round window is at the phase of rarefaction. If the sound waves were to strike both the windows simultaneously, they would cancel each other's effect with no movement of the perilymph and no hearing. This acoustic separation of windows is achieved by the presence of intact tympanic membrane and a cushion of air in the middle ear around the round window

Natural resonance of external and middle ear - Inherent anatomic and physiologic properties of the external and middle ear allow certain frequencies of sound to pass more easily to the inner ear due to their natural resonances. Natural resonance of external ear canal is 3000Hz and that of middle ear

800Hz. Frequencies most efficiently transmitted by ossicular chain are between 500 and 2000 Hz while that by tympanic membrane is 800-1600 Hz. Thus greatest sensitivity of the sound transmission is between 500 and 3000 Hz and these are the frequencies most important to man in day to day conversation.

2. Transduction of Mechanical Energy to Electrical Impulses

Movements of the stapes footplate, transmitted to the cochlear fluids, move the basilar membrane, setting up shearing force between the tectorial membrane and the hair cells. The distortion of hair cells gives rise to cochlear microphonics which trigger the nerve impulse. A sound wave, depending on its frequency, reaches maximum amplitude on a particular place on the basilar membrane and stimulates that segment (travelling wave theory of van Bekesy). Higher frequencies are represented in the basal turn of the cochlea and the progressively lower ones towards the apex

3. Neural Pathways

Hair cells get innervation from the bipolar cells of spiral ganglion. Central axons of these cells collect to form cochlear nerve which goes to ventral and dorsal cochlear nuclei. From there, both crossed and uncrossed fibres travel to the superior olivary nucleus, lateral lemniscus, inferior colliculus, medial geniculate body and finally reach the auditory cortex of the temporal lobe.

CHRONIC SUPPURATIVE OTITIS MEDIA -TUBOTYMPANIC DISEASE

Otologists for many years have attempted to establish a uniform terminology to describe the clinical and pathological features of chronic middle ear disease. The lack of universally accepted definitions is testimony to the difficulty involved in this process. The basic feature common to all cases of chronic suppurative otitis media is the presence of a non-intact tympanic membrane. With this in mind a relatively simple working definition of these conditions is 'chronic or intermittent otorrhoea through a persistent non-intact tympanic membrane'. The reference to a non-intact tympanic membrane in most cases denotes a perforation, but can also include discharge through a ventilation tube.

Otologic History and Physical Examination of the Ear [8,10]

The history and physical examination are the most important components of the evaluation of a patient with a hearing or balance disorder. They enable the clinician to develop a differential diagnosis before audiologic or vestibular testing and provide the basis for treatment planning.

Clinical features

Symptomatology

The two classic symptoms of chronic suppurative otitis media are otorrhoea and deafness which can affect one or both ears. The discharge can be continuous or intermittent and varies in character from serous or mucoid to frankly purulent. An increase in the amount of discharge can be precipitated by upper respiratory tract infections or by contamination from the external canal after bathing or swimming. Bloodstained discharge is found in association with florid granulation tissue and aural polyps and is a frequent indicator of underlying cholesteatoma. Persistent otorrhoea unresponsive to medical treatment can indicate a so-called “mastoid reservoir" of disease with inflammation throughout the middle ear cleft. The predominant deafness in chronic middle ear disease is conductive in nature. Factors that influence the degree of conductive deafness are as follows.

- The size and position of the tympanic membrane defect: large perforations will reduce the efficiency of the tympanic membrane to a greater degree. Perforations exposing the posterior mesotympanum produce a more severe deafness owing to a reduction of the 'baffle' effect on the round window. Small anterior defects often produce no deafness.
- Impairment of the ossicular chain: this occurs through bony loss most commonly of the incus long process or stapes superstructure. Ossicular fixation either by new bone formation or tympanosclerosis can also increase the degree of deafness.
- The presence of middle ear pathology such as oedema and granulation tissue can also influence the sound conducting mechanism.

More recently the occurrence of sensorineural deafness in chronically discharging ears has been recognized. A study by Paparella et al found a definite increase in the incidence of sensorineural loss in patients of all ages with chronic suppurative otitis media ranging from mild to severe. This loss is mainly in the high frequencies and is thought to result from the passage of bacterial toxins across the round window membrane to the cochlea.

Examination Findings

The principal examination finding in chronic suppurative otitis media is the tympanic membrane defect. In ears without cholesteatoma the perforation is almost always of the central type. Perforations can vary in size from a pinhole-type defect to the large subtotal defect. The activity of the disease will be indicated by the degree of discharge. In inactive cases there is no discharge and the middle ear is dry. In active cases the discharge can be mucoid or purulent. Pulsatile purulent discharge occurs in heavily infected cases with capillary engorgement of middle ear mucosa.

Depending on the size of the perforation various middle ear structures may be seen. The middle ear mucosa may be normal or edematous. In ears with florid inflammation an aural polyp may be present, arising from the middle ear mucosa or the margins of the perforation. In some cases the aural polyp may be large enough to fill the external auditory canal and may manifest at the lateral meatus.

The integrity of the ossicular chain can often be observed through the perforation. Ossicular abnormalities most commonly seen are disruption of the incudostapedial joint, necrosis of the incus long process and medial retraction and shortening of the malleus handle. Other middle ear structures visible through perforations are the eustachian tube orifice, the promontory (with the tympanic plexus) and the niches of the oval and round windows. The actual round window membrane is usually hidden from view and protected by mucosal folds.

INITIAL ASSESSMENT

When a patient with chronic suppurative otitis media first presents to an otologist a number of diagnostic steps are essential. The most important maneuver involves accurate documentation of the tympanic membrane defect. To this end examination with an operating microscope and adequate suction equipment is required. In adults microscopic examination can be carried out as an outpatient or 'office' procedure. In young children, however a short general anesthetic is sometimes required, particularly if suction is needed. The nature of the tympanic membrane defect and any associated middle ear or external canal pathology should be noted. A drawing of the tympanic membrane should be made in the case records.

During microscopic examination of the ear, if there is discharge a microbiology swab should be taken. Microbiological investigation should aim to identify aerobic and anaerobic pathogens. The laboratory should be informed of any prior treatment with topical or systemic antimicrobial drugs and of any intention to treat with particular agents so that sensitivity studies can be undertaken.

Although a hand-held otoscope is useful as a screening tool, its use is limited by the absence of binocular vision. An operating microscope is used when there is any question regarding the status of the ear. Careful cleaning of the external auditory canal is a prerequisite for otologic diagnosis. Cerumen, desquamated skin, and purulent debris must be completely removed with loops, alligator forceps, curettes, or suction.

Otoendoscopic examination

Video otoscopic examination can be performed easily in the office and assists greatly in photo documentation and patient counseling. With video monitors in direct patient view, patient can better appreciate any pathologic process because they can see for themselves the ear and external canal. Video otoscopic examination can be performed with the 0^0 sinus scopes found commonly in the otolaryngologist's office or with easier to use shorter otoscopes designed for otoscopic examination.

Although middle ear endoscopy was first described by Mer et al in 1967, it has been only recently that optics of small endoscopes have approached microscopic quality [20]. The Achromat lens scope utilizes serial thin lenses to relay the image. It is commonly used when a larger scope is applicable. The rod lens scope, first developed by Hopkins uses rod-shaped glass lenses in the relay system. The lenses are thick and the air spaces are small. The rod lens provides for a wider viewing angle and exceptional resolution and brightness. Most sinus endoscopes and smaller endoscopes belong in this category. The Selfoc scope has reduced image quality, but a more durable and cheaper scope when compared with the rod and Achromat lens scopes.

<u>Basic definitions of terms used in endoscopy include the following [1]:</u>

“Length" or "functional length" does not include the handle or the eyepiece. Shorter endoscopes, less than 16 cm, are difficult to use in otologic procedures, because the bulky eyepiece and camera are close to the ear and are within the range of movement of the hand holding instruments. Smaller diameter endoscopes have a very limited field of view and do not provide much advantage over the limited angle of view of the microscope. The 4-mm diameter of the scope has not been a limiting factor, even in small ear canals.

"Direction of view" is the angle between the mechanical axis and the center of the field of view

“Field of view” is the angle measured at the tip of the endoscope to 2 points at the extreme diameter of the viewed field. This tends to increase substantially with the diameter of the endoscope; hence, it is advantageous to use the largest-diameter endoscope possible.

"Depth of field" is the distance between an object placed as close as possible to the distal tip of the scope while remaining in focus (near object distance) and an object placed as far as possible from the distal tip of the scope while remaining in focus (far object distance). It is essential to use a video camera to be able to adjust the focus of the camera to compensate for the loss of focus experienced at the level of the endoscope. It is exceedingly hard to perform otologic procedures directly off the endoscope [1].

There are 2 major safety concerns with otoendoscopy. One is excessive heat dissipation. This was evident only when a xenon light source was used. Adequate illumination of the middle ear space can be accomplished with lower settings on the regular light source without the need for xenon systems. As well, the tip of the endoscope requires continuous cleaning with antifog solution, which probably helps in cooling the endoscope. The other safety concern is accidental patient movement with secondary direct trauma by the tip of the endoscope. The relatively large diameter of the endoscope (4 mm) and the anatomy of the ear canal and middle ear space will usually preclude the introduction of the endoscope beyond the tympanic ring.

The many advantages of the endoscope include a wide angle of view. The endoscopic view usually includes the whole tympanic ring and ear canal at the same time. It is not defined by the narrowest segment of the ear canal. This provides a complete view of the middle ear space, tympanic membrane, and ear canal without the need for continuous repositioning of the surgeon's head and the microscope

Another advantage is better visualization of structures that are parallel to the axis of the microscope It is usually necessary to position structures at a right angle to the axis of the microscope for adequate visualization, which is difficult to impossible in certain situations. The 30° scope and the wide-angle 0°scope provide excellent visualization of structures such as the ear canal. Another advantage is visualization of hidden structures such as an anterior tympanic membrane perforation and the sinus tympani, facial recess, attic, and hypotympanum. This is possible through a trans canal approach, even when using the 0° scope, because of wide-angle view of the more recent endoscopes. Another advantage is the ability to visualize past shaft of instruments such as suction tips.

Disadvantages of the endoscope include the loss of depth perception and binocular vision. This is easily compensated for with experience. In otoendoscopy, the introduction of the instrument into the field and the way it is visualized on the monitor provide for tactile and visual cues that are used by experienced endoscopist to reconstruct a 3-dimensional view of the middle ear. Even though newer endoscopes might provide that depth perception, this issue is more related to the experience of the surgeon than the limitation of the available scopes. Other disadvantages include one handed technique, need for physician training and cost of equipment.

The impact of the endoscope on middle ear surgery will have to be considered on the basis of the task contemplated and the importance of these advantages and disadvantages in specific situations.

In inspection of the middle ear space, the endoscope is the better instrument, for the above-discussed reasons. These include the ability for operative evaluation and treatment of disease within the facial recess, sinus tympani, hypotympanum, attic, and the anterior part of the tympanic cavity.

An assessment of hearing loss should be made initially by standard Rinne and Weber tuning fork tests .Pure tone audiometry with air and bone conduction threshold estimation should be performed. Adequate masking is essential, particularly in patients with bilateral conductive or mixed hearing loss. Speech audiometry is often helpful and is required for any patient in whom surgical reconstruction is being considered.

Radiological examination is not necessary in uncomplicated cases of chronic suppurative otitis media without cholesteatoma.

Histopathology [11,12]

The histopathological changes seen in chronic suppurative otitis media vary with the degree and extent of disease. The degree of inflammation seen is related to clinical activity, with the most intense changes seen in ears with continuous otorrhoea.

The middle ear cleft is lined by a single layer of cuboidal or columnar epithelium, which may bear cilia. Goblet cells are a feature of the hypotympanum and the region below the horizontal course of the facial nerve, whereas above and behind this region the lining cells are flat and devoid of glandular structures. The changes occurring in chronic otitis media without cholesteatoma are as follows.

A chronic inflammatory infiltrate consisting of lymphocytes, plasma cells and histiocytes develops. Associated with this is increased capillary permeability of the lamina propria of the middle ear mucosa, with mucosal oedema.

The middle ear epithelium undergoes transformation to resemble respiratory epithelium found in other sites. This consists of an increase in the number of goblet cells and ciliated cells. In addition the epithelium becomes glandular. This change in character of the epithelium may take place in the mastoid air cells as well as in the middle ear cavity. The secretion from newly formed glands is an important part of the discharge seen in chronic suppurative otitis media.

An inflammatory granulation tissue develops during the early stages of healing after destruction of tissue. In some cases florid granulation tissue results in the gross appearance of an aural polyp. The polyp is usually covered by ciliated columnar epithelium. Occasionally polyps are covered with squamous epithelium, which may occur by metaplastic change. Although aural polyps can occur in all types of chronic suppurative otitis media, their histological features can be used as a predictor of underlying cholesteatoma. Another chronic inflammatory change seen in some diseased ears is the cholesterol granuloma.

The late stages of the disease are characterized by a decrease in vascularity and fibrosis. These changes are particularly well seen in the mastoid air cells. in which sclerosis and new bone formation can occur.

Tympanosclerosis is a special form of fibrosis often occurring in chronic suppurative otitis media.

Ossicular changes in Chronic Suppurative Otits Media without cholesteatoma

The main ossicular lesion is bony resorption. This occurs either as a result of osteoclastic activity in relation to granulation tissue or by avascular necrosis. The parts of the ossicular chain most prone to bony loss by avascular necrosis are the long process of the incus and the stapes superstructure. Occasionally new bone formation can occur which can have the effect of fixing the heads of the malleus and incus in the attic.

TYMPANOSCLEROSIS

Tympanosclerosis is often associated with chronic suppurative otitis media. It also occurs in the absence of tympanic membrane defects, especially in ears that have suffered with recurrent acute suppurative otitis media. Multiple ventilation tube insertions are a particular risk factor in the development of tympanosclerosis. The macroscopic appearance is of dense white deposits laid down in the tympanic membrane and within the tympanomastoid cavity. In the middle ear cleft these deposits may be related to the ossicular chain, particularly the stapes crura and footplate. Microscopically there is hyalinization of collagen and calcium deposition with a characteristic lamellar structure. In advanced cases bony change (heterotopic ossification) can occur. Tympanosclerosis is thought to be the result of a specific autoimmune reaction against the lamina propria of the tympanic membrane or the basement membrane of the middle ear mucosa.

MEDICAL TREATMENT

The aim of medical treatment in uncomplicated cases of chronic suppurative otitis media is to eliminate infection and hence control otorrhoea. Correction of hearing loss and re-establishment of an intact tympanic membrane may require a surgical procedure. The successful treatment of chronically discharging ears requires close otological supervision. The treatments available have been somewhat controversial largely because of the potential risks of topical agents. The various modalities available are described below.

Aural toilet

The removal of discharge from an ear with active chronic suppurative otitis media is an essential prerequisite for successful treatment. At the initial assessment examination with an operating microscope with suction apparatus would have been performed. This microscopic aural toilet may need to be repeated, sometimes daily, until resolution of discharge occurs. Aural toilet is particularly important when topical medication is used. as profuse discharge may prevent the topical agents from reaching the middle ear in sufficient concentration. The use of cotton-tipped applicators by patients, under supervision can be useful in mopping up discharge from the lateral parts of the ear canal, as long as patients are aware of the trauma that can be caused by inserting the applicator too deeply. Some otologists perform gentle syringing of the ear with isotonic saline at body temperature to remove discharge. In patients who have severe canal narrowing due to secondary otitis externa the tympanic membrane may not be visible initially. In these patients attention to the canal skin, with the use of medicated wicks if necessary, is needed as a primary measure.

Topical medications

Topical agents used in the treatment of chronic middle ear disease are a combination of antibiotics, antifungals, antiseptics, solvents and steroids. Preparations are usually in liquid form and should be administered by the displacement method. In this method the ear to be treated is placed uppermost and ear drops instilled. Pressure on the tragal cartilage forces the drops through the perforation into the middle ear. The controversy surrounding topical therapy centres on potential ototoxicity. The commonest antibiotics to be used topically for chronic suppurative otitis media are aminoglycosides, with gentamicin, framycetin and neomycin being common constituents of aural preparations. Aminoglycosides administered systemically are potent cochleovestibular toxins when their serum concentration exceeds known levels. Ear drops containing aminoglycosides are widely used by otologists in treating chronic middle ear disease. Theoretically, topical agents can gain access to the inner ear through the round window membrane. Most studies of the ototoxicity of topical preparations have been performed in laboratory animals in whom the anatomy of the round window niche differs substantially from that of the human. The scientific literature contains sporadic reports of sensorineural deafness associated with the use of topical agents. However, planned clinical studies in humans have failed to show significant sensorineural deafness attributable to their use.

Surgical Treatment of Chronic Otitis Media [12]

Aims

The most important aims of surgery for chronic otitis media are the creation of safe, dry ear by elimination of disease and, if possible, restoration of middle ear function and the sound conducting mechanism. These goals include the prevention of recurrent disease and the avoidance of surgical complications. The importance of middle ear aeration also is emphasized. Cosmetic considerations including maintenance of normal anatomy and appearance are secondary.

Preoperative Assessment

Preoperative assessment, patient counseling, and surgical planning are multifactorial in patients with chronic otitis media. Considerations should include the degree of hearing impairment and the presence of otorrhea, pain, facial nerve dysfunction, or vertigo. The presence and type of perforation (whether total, marginal, central, pars tensa, or pars flaccida) and status of middle ear mucosa, eustachian tube, degree of mastoid pneumatization, and ossicles are assessed. The presence of an intact ossicular chain portends a better prognosis for hearing results. In the absence of an intact ossicular chain, the status and mobility of the stapes is particularly important. Tuning fork tests should accompany audiologic evaluation. Conductive hearing losses of 20 dB or less usually predict an intact ossicular chain when cholesteatoma is absent. Cholesteatoma itself may transmit sound through mass effect and may reduce the conductive deficit in the presence of ossicular chain discontinuity. An ossicular defect should be suspected with a conductive loss of greater than 30 dB.

Assessment of the temporal bone may be accomplished by high-resolution computed tomographic (CT) scan preoperatively. There is controversy regarding the role of CT for routine evaluation of chronic otitis media. Leighton et al.found the operative plan was altered in 50% of cases when preoperative imaging was utilized. Although routine imaging for chronic otitis media probably is not necessary, revisions or cases of suppurative complication or those surgeries in the only hearing ear are appropriate for preoperative imaging. Some believe that in children and the medically infirm, in limited tympanic membrane visualization on otoscopy, congenital cholesteatoma, former disease of the sinus tympani or facial recess, suspected labyrinthine fistula, or in a substantially better hearing ear, preoperative imaging may be useful.

CT is most helpful in identifying the extent of soft tissue disease and bone erosion, although it may be difficult to distinguish between mucosal disease and cholesteatoma. The position of the tegmen and sigmoid sinus, and the degree of mastoid sclerosis, are well delineated. Fistulas are identified with approximately 75% accuracy and 3.5% false-positive rate. Axial images are more helpful for this, although coronal images generally are better suited for temporal bone evaluation in chronic otitis media. Fistulas less than 2 mm are less likely to be detected.

Detection of ossicular abnormalities is limited. The malleus head and long process or body of the incus usually are well imaged, and the stapes superstructure often is seen as well. However, the most common ossicular abnormalities in chronic otitis media, erosion of the long process of incus or stapes superstructure, are difficult to identify accurately. Likewise, the manubrium is notable in only one third of cases . Facial nerve dehiscence and dural exposure are diagnosed much less accurately by CT.

Prior to surgery, adjuvant therapies for concurrent or exacerbating conditions are implemented. Control of infection via cleaning and topical antibiotic and irrigant therapy is advocated. Although control of otorrhea is important, surgery is still appropriate if it persists. Some believe that sinonasal disease, allergy, immunodeficiency, and consideration of adenoidectomy should be included in preoperative assessment as predisposing factors for chronic otitis media, whereas others feel that these factors influence surgical results in a very small percentage of cases and should be addressed in treatment failures.

Preoperative patient counseling should include discussion of the probable outcomes regarding the aims of surgery, complications of untreated disease, potential for recurrence, and hearing loss. The possibility of, and rationale for, staging including examination for recurrence and better hearing results also are discussed. Risks of surgery are described, including bleeding, infection, hearing loss, tinnitus, dizziness, injury to the facial nerve, chorda tympani symptoms, cerebrospinal fluid leaks, and anesthesia risks.

Contraindications

Children less than 6 to 8 years of age generally are not candidates for tympanoplasty secondary to their susceptibility to recurrent otitis media. Ears with poor cochlear reserve may benefit from surgery to control infection, but not for hearing restoration.

Surgery on an only hearing ear should be avoided when possible, given the 2% risk of sensorineural hearing loss and higher risk in the presence of fistula. In patients at risk for further hearing loss or suppurative complications because of persistent or uncontrolled disease, surgery may be carried out safely by experienced surgeons and with minimized risk of hearing loss. When hearing losses do occur, they are typically minor high-frequency losses secondary to drill related trauma or ossicular manipulation. Rarely does a dead ear result and typically would involve those cases complicated by the presence of fistula.

Severe inflammatory disease of the external canal may affect the success of surgery; however, active middle ear infection and otorrhea are not contraindications. In some cases, the neovascularization may aid healing, although the thickened skin and mucosa may result in additional operative challenges and bleeding.

TYMPANOPLASTY [12]

Tympanoplasty essentially involves grafting of the tympanic membrane, surgery of middle ear contents with removal of disease, and reconstruction of the ossicular chain with restoration of a middle ear space. Avoiding fibrosis and middle ear collapse while recreating a sound conducting connection between the tympanic membrane and cochlea are key elements to successful tympanoplasty. The aims of tympanoplasty surgery include an intact tympanic membrane, an air-containing middle ear space, and a secure connection between the eardrum and the cochlea.

During the 1950s, the development of tympanoplasty techniques furthered the goal of hearing restoration. Early success was limited by difficulties in maintaining a mucosalized, aerated middle ear cleft primarily due to the formation of adhesions bet\veen the tympanic membrane graft and the middle ear or promontory. Modifications and improvements in these techniques have resulted in the current state of the art.

In the l870s, Kessel developed the early concepts of tympanoplasty, middle ear aeration, and ossicular reconstruction. However, in the 1950s Wullstein and Zollner ushered in the modem era of tympanic membrane grafting and tympanoplasty. Closures of the tympanic membrane to prevent infection with promotion of a vibratory surface were among their noteworthy goals.

Wullstein initially described five types of tympanoplasty[12] based on the relationship of the grafted tympanic membrane to the middle ear structures of sound conduction. His results showed a significant improvement in hearing, particularly when the stapes was present and functional. He also emphasized the work of Juers, Davis, and Walsh, who showed that the two major functions of the tympanic membrane are oval window sound pressure transformation and round window sound protection. Perforation eliminates sound protection for the round window in the presence of an intact conductive mechanism.

Types of tympanoplasty according to Wullstein:

Type I: with restoration of the normal middle ear.

Type II Ossicular chain partially destroyed but preserved and continuity restored. Skin graft laid against the osslcles after removal of the bridge.

Type III Myringostapediopexy producing a shallow middle ear and a columella effect.

Type IV Round window protection with a small middle ear; mobile footplate left exposed.

Type V Closed middle ear with round window protection; fenestra in the horizontal semicircular canal covered by a skin graft

Early use of full- and split-thickness skin grafts was fraught with healing problems, eczema, and recurrent perforation. Canal skin was used but likewise abandoned due to graft problems that included perforation and a 40%

failure rate. These difficulties eventually led to the progressive use of autogenous grafting materials, including vein, temporalis fascia, and tragal perichondrium. Storz described the use of temporalis fascia for the overlay technique in the early 1960s. Whereas small central perforations with intact ossicular chains possibly may be closed with simple myringoplasty, tympanoplasty is used for more extensive perforation and disease. In myringoplasty, surgery is limited to the tympanic membrane and does not involve elevation of a tympanomeatal flap or entering the middle ear. Fat patch myringoplasty, which involves closure of a small perforation with a dumbbell of adipose tissue, is an example of this type of surgery.

Two methods dominate current tympanoplastic tcchniques. These include the overlay or lateral graft and the underlay or medial graft techniques. Both provide the prerequisites for successful reconstruction. When mastered, either gives high and comparable rates of success.

Transcanal or postauricular approaches may be used for the tympanoplasty. The trans canal approach is less invasive but has anterior exposure limits. Tragal perichondrium is easily within the surgical field for harvest. A postauricular approach provides superior visualization for anterior or subtotal perforations. It naturally allows for ready access to temporalis fascia. Because of the superior overall exposure, the grafting success rate is higher through a postauricular approach.

MATERIALS AND METHODS

MATERIALS

1. Patients:

Inclusion Criteria

1. Patients with persistent ear discharge with or without hearing loss presenting to the ENT out patient department between November 2005 and July 2006.
2. Patients who are found to have pars tensa perforation on ENT examination
3. Patients who give consent for the study including Otoendoscopy

Exclusion Criteria

1. Patients who are in paediatric age group and presenting with ear discharge and hearing loss
2. Patients who have CSOM-Attico antral disease
3. Patients whose symptomatology is suggestive of CSOM-TTD with complications
4. Patients who are having inflammatory conditions of the external ear at the time of presentation
5. Patients with major systemic illnesses in whom active surgical intervention for CSOM-tubotympanic disease might not be undertaken.
6. Patients who are pregnant women.

2. Setting:

The study was done in ENT department of Christian Medical College Hospital, which is a tertiary care teaching hospital, under supervision of the guide.

3. Period :

The study was conducted between November 2005 and July 2006

4. Sample size estimation:

Sample size $n = \frac{(Z_{\alpha} + Z_{1-\beta})^2 p x q x 2}{d^2}$

Z_{α} -- Type I error(1.96)(α-0.05)

$Z_{1-\beta}$ -- Power of test(β-0.1)

p -- Prevalence

q -- (100-p)

d -- 10%

$$= \frac{10.4x3x97x2}{100} = 60$$

n=No of ears included for study

5. Statistical analysis:

Statistical analysis was done using the SPSS version/PC+ program on an IBM compatible computer. Chi square test was used to determine the relationship and significance of the different variables.

METHODOLOGY:

Parameters Studied:

- External Auditory Canal
- Tympanic membrane Perforation
- Middle ear mucosa
- Eustachian tube orifice(lateral end)
- Protympanum
- Hypotympanum
- Ossicular status- malleus/Incus/stapes
- Presence or absence of Tympanosclerosis
- Other incidental findings: hidden Cholesteatoma/granulations

Prior to the commencement of the study, a proforma was designed and a statistician consulted. The proforma included the demographic profile of the patients along with the various parameters of the study to be evaluated. The proforma is divided into two parts with both parts having the same parameters of study compiled into a tabular form. Each parameter of the study and there subgroups have been given a score ex 1, 2, 3, or 4. The first part of the proforma is for documenting the otomicroscopy findings whereas the second part is for documenting otoendoscopy findings.

Patients who are above 12 years of age presented to ENT OPD at Christian Medical College Hospital between November 2005 and July 2006 with recurrent ear discharge and hearing loss and who were diagnosed by qualified ENT surgeons in the department to have chronic suppurative otitis media- tubotympanic disease were enrolled in this study. The nature and purpose of the study was explained to each patient and an informed consent is taken both verbally and in writing.

Otomicroscopy is done on all patients diagnosed to have chronic suppurative otitis media- tubotympanic disease and meeting the inclusion criteria, by the attending ENT surgeon and the proforma filled by him or her. Other investigations including routine blood investigations, pure tone audiogram, x-ray mastoids and rigid nasal endoscopy were done for all the patients.

Otoendoscopy was then done on the same patients after obtaining the consent in the outpatient department . If the patients are posted for surgery in the same week then otoendoscopy was done on the operating table after the patient is intubated for general anesthesia but before the patient is draped for surgery. Two types of rigid endoscopes were used one is a 2.7mm 30^0 tympanum scope (11cm) and the other one being a regular 4.0mm 45^0 rigid nasal endoscope (18cm).

A storz / sony tri chip camera was attached to the endoscope and whole procedure of otoendoscopy was recorded using pinnacle software and findings are filled in another proforma having same variables as used for microscopy.

MICROSCOPIC EXAMINATION OF EAR

VIDEO-OTO ENDOSCOPY

RESULTS

DEMOGRAPHIC PROFILE

Age distribution (Fig.1)

The mean age of the patients included for the study was 32.11 with the youngest of the group being 14 years old and the oldest 56 years old.

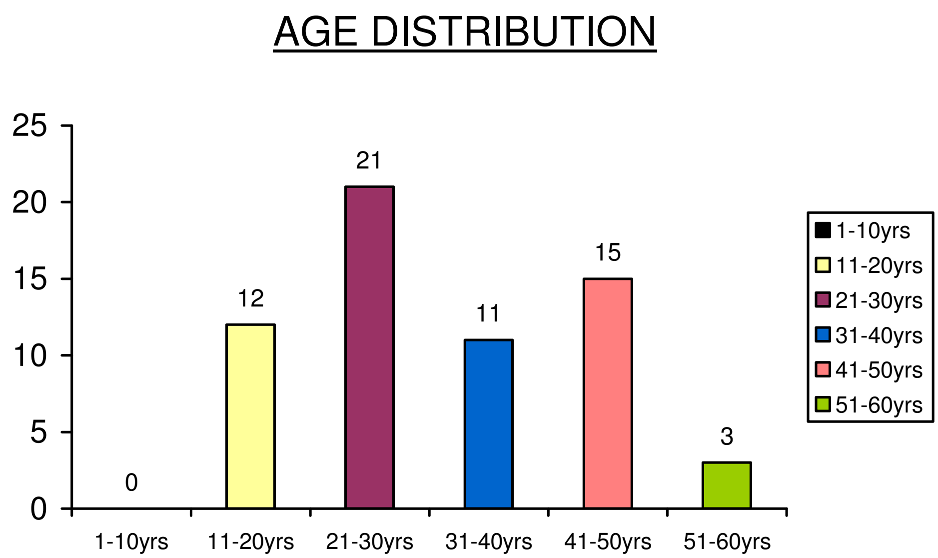

AGE DISTRIBUTION
25
20
15
10
5
0
21
12
11
15
3
0
1-10yrs
11-20yrs
21-30yrs
31-40yrs
41-50yrs
51-60yrs
1-10yrs
11-20yrs
21-30yrs
31-40yrs
41-50yrs
51-60yrs

Fig. 1

Sex and side distribution (Fig. 2a and2b)

A total of 54 patients who have satisfied the inclusion criteria were enrolled in the study. 8 of this patients had bilateral ear disease .There were 34(54.8%) males and 28(45.2%) females in the study. There were equal numbers of right and left ears examined in this study

SEX DISTRIBUTION

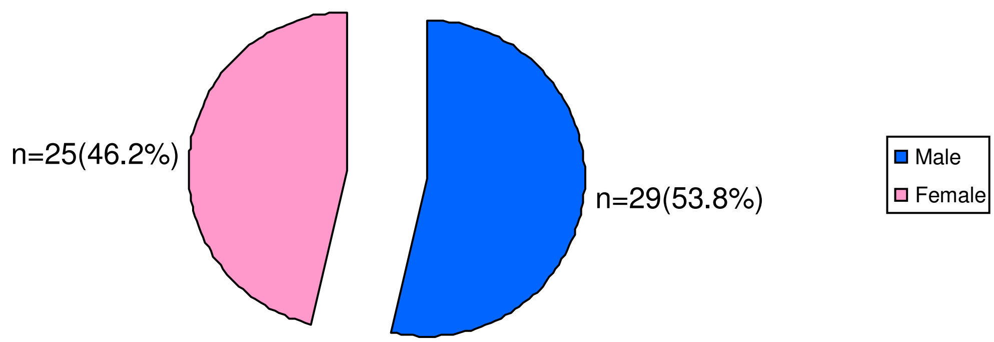


Fig. 2a

SIDE OF DISEASE

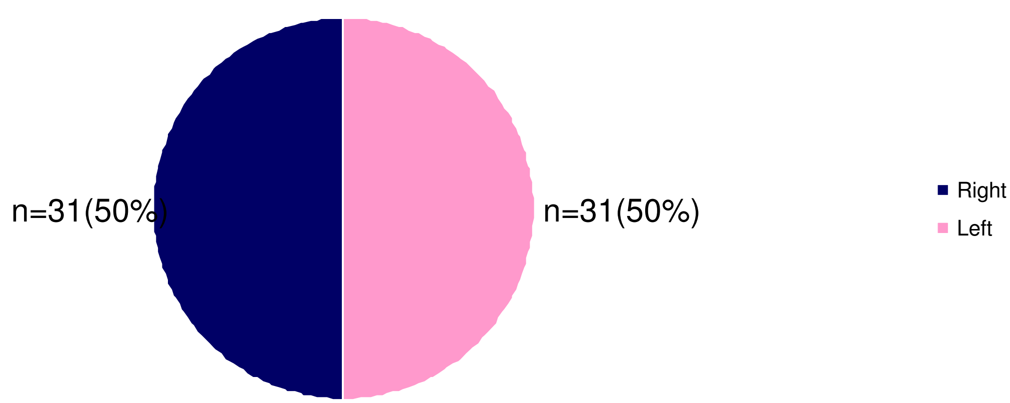


Fig. 2b

Status of the CSOM (Fig. 3)

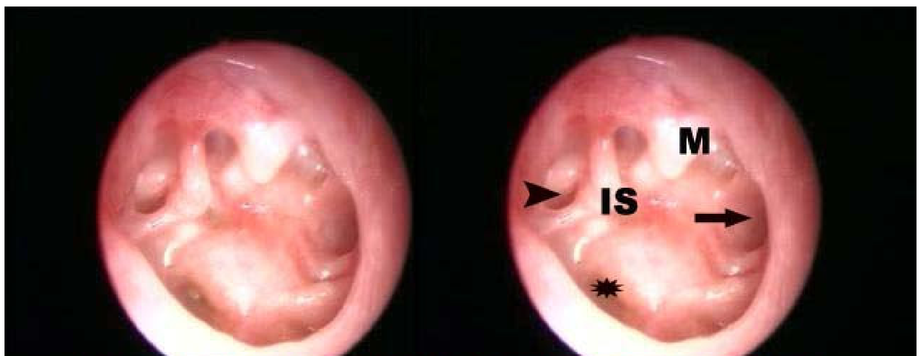
26 of the ears examined had an active disease (ie ear discharge occurring at least once in the prior 2 months) at the time of enrollment while 36 of the ears examined had inactive disease.

Table 1 (Fig. 4)

Analysis of examination of External auditory canal

EAC	Normal	Narrow	Tortous	p-value
Microscope	57(91.9%)	4(6.5%)	1(1.6%)	
Otoendoscope	56(90.3%)	5(8.1%)	1(1.6%)	0.942

The results found after the examination of external auditory canal has shown almost similar results by both microscopy and otoendoscopy. The p-value for this parameter of study was greater than 0.05(table 1) indicating that there is no statistically significant difference between microscope and otoendoscope in the evaluation of the external auditory canal.



OTO ENDOSCOPY- Normal Middle Ear
M- malleus IS- incudostapedial joint
➡ ET orifice ➤ Oval window ✸R. window

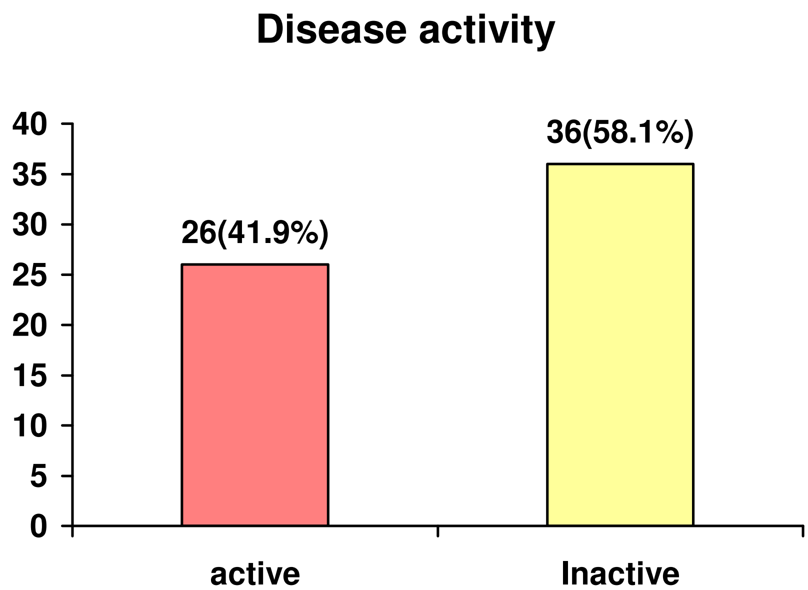

Disease activity
40
35
30
25
20
15
10
5
0
26(41.9%)
36(58.1%)
active
Inactive

Fig. 3

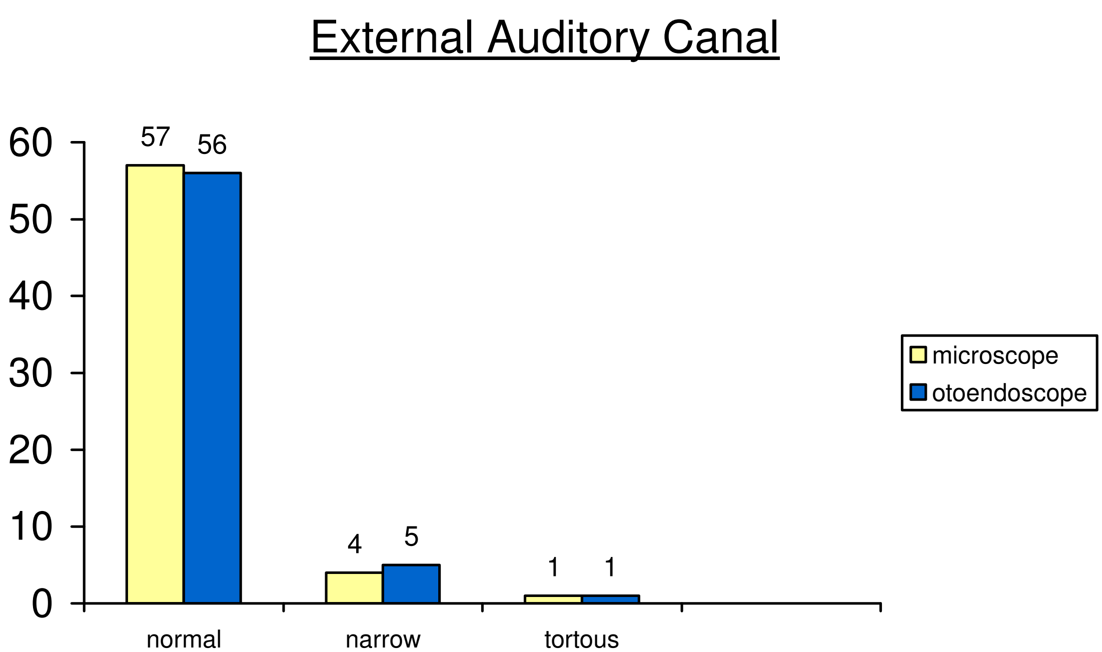

External Auditory Canal
60
50
40
30
20
10
0
57
56
4
5
1
1
normal
narrow
tortous
microscope
otoendoscope

Fig. 4

Table 2 (Fig. 5)

Analysis of examination of pars tensa perforation

Perforation	Small	Moderate	Large	Subtotal
Microscope	4(6.5%)	16(25.8%)	29(46.8%)	13(21%)
Otoendoscope	4(6.5%)	14(25.6%)	23(37.1%)	21(33.9%)

p-0.439

In the evaluation of the size of perforation of the pars tensa the otoendoscopy findings were almost similar in the small and moderate perforations but there is difference among the findings in large and subtotal perforations. However the difference is insignificant statistically as indicated by the p-value which is greater than 0.05. The lack of any advantage of the otoendoscopy in these two parameters is probably because the external auditory canal and pars tensa are not hidden areas of the ear.

Table 3 (Fig. 6)

Analysis of examination of middle ear mucosa

M.E.Mucosa	Normal	Congested	Edematous	Polypoidal
Microscope	40(64.5%)	9(14.5%)	11(17.7%)	2(3.2%)
Otoendoscope	35(56.5%)	2(3.2%)	24(38.7%)	1(1.6%)

p-0.019

In the evaluation of middle ear mucosa it was possible to detect edematous mucosa in only 11(17.7%) of cases by microscopy whereas 24(38.7%) cases of edematous middle ear mucosa were detected by otoendoscopy. This finding was statistically significant (p-value<0.05)

Type of perforation

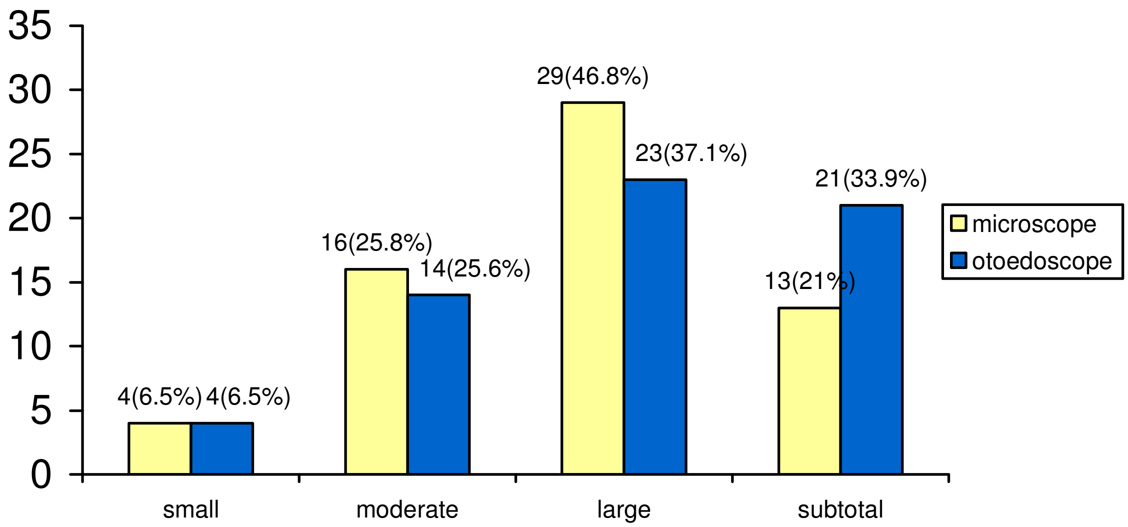


Fig. 5

Middle ear mucosa

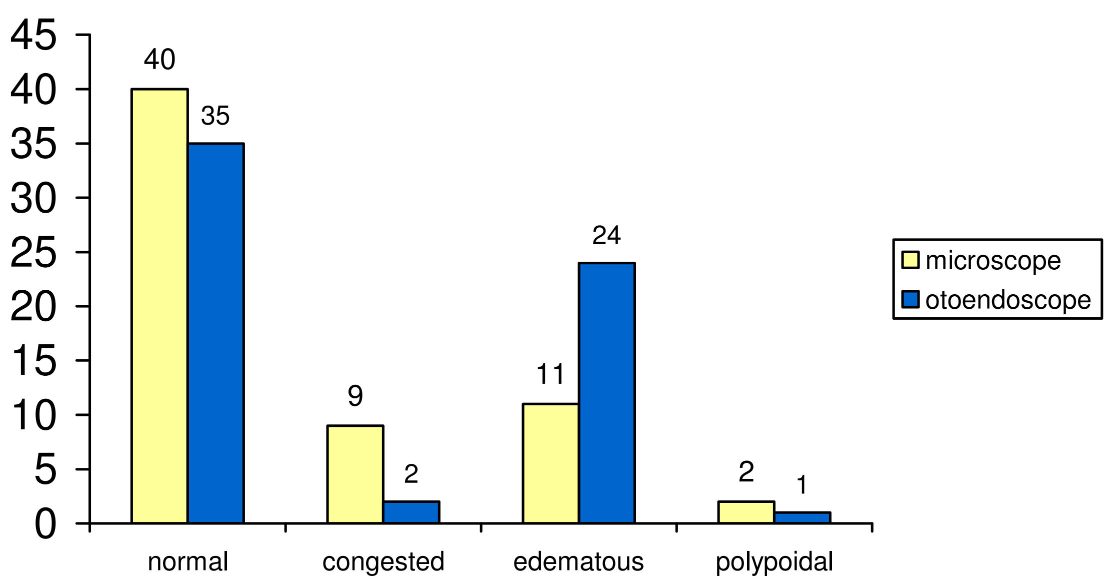
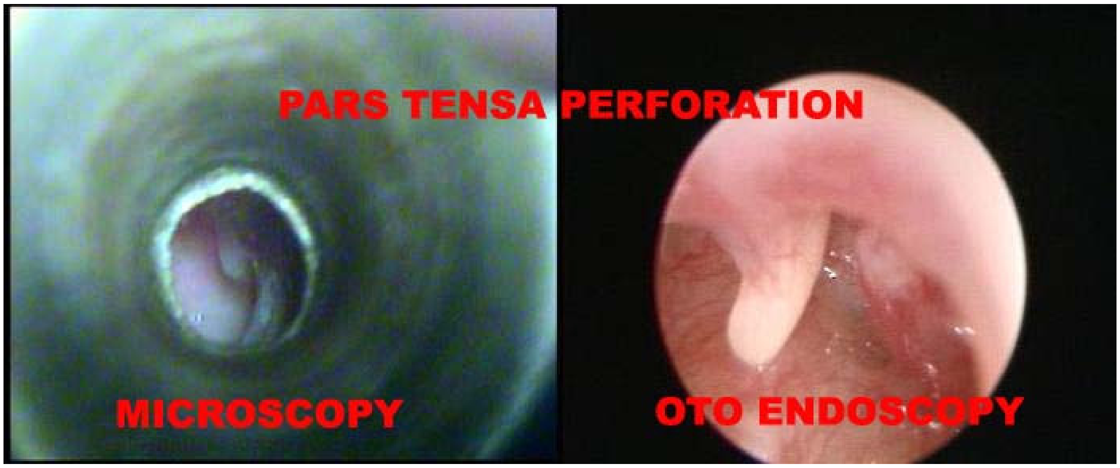


Fig. 6


PARS TENSA PERFORATION
MICROSCOPY
OTO ENDOSCOPY


NORMAL
ODEMATOUS
OTO ENDOSCOPY middle ear mucosa

Table 4 (Fig. 7)

Analysis of examination of Eustachian tube orifice

E.T.Orifice	**Seen**	**Not Seen**
Mcroscope	18(29.0%)	44(71.0%)
Otoendoscope	58(93.5%)	4(6.5%)

p-0.000

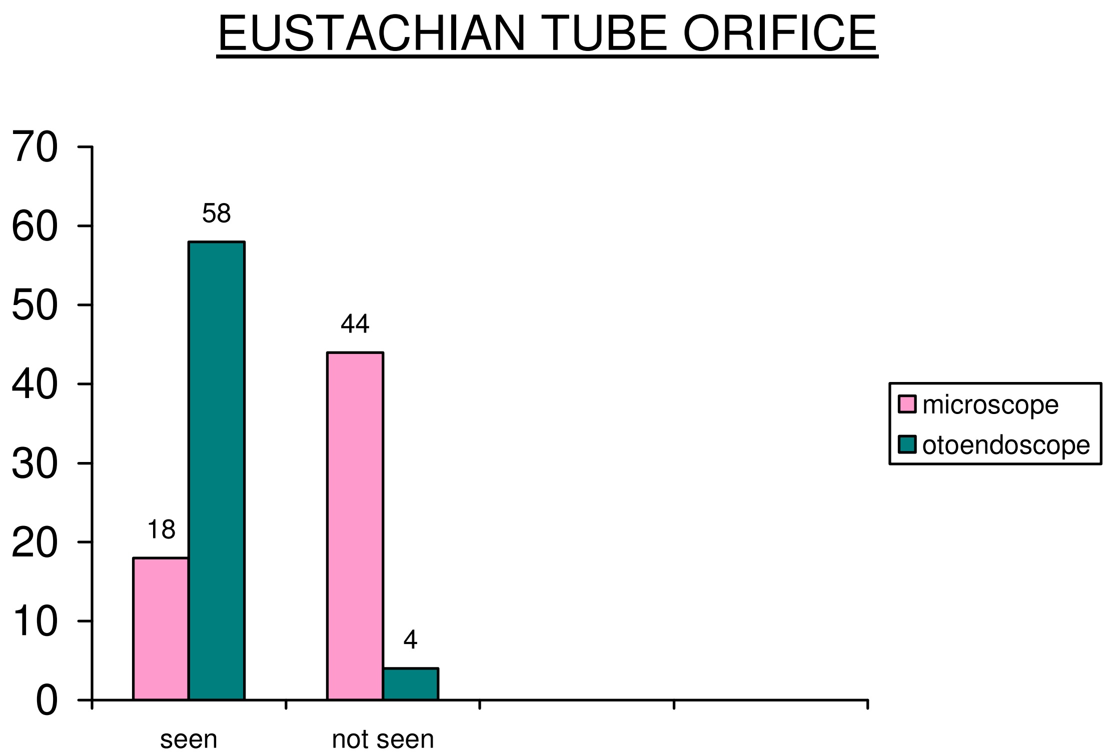

EUSTACHIAN TUBE ORIFICE
70
60
50
40
30
20
10
0
58
44
18
4
seen
not seen
microscope
otoendoscope

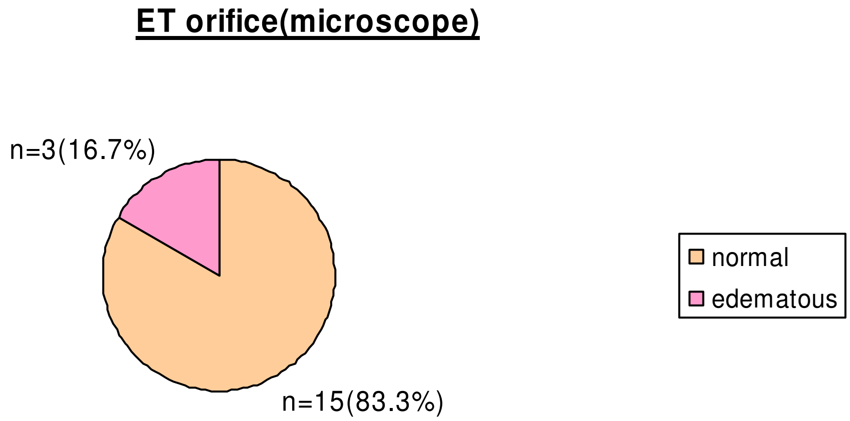
Fig. 7

Table 4a (Fig. 7a)

E.T.Orifice(seen)	Normal	edematous	Granulations
Microscope	15(83.3%)	3(16.7%)	
Otoendoscope	40(68.9%)	15(25.9%)	3(5.2%)

p-0.000

The eustachian tube area which is situated in the anterior tympanum is hidden from view and is only occasionally seen through the microscope. In this study while in only 18(29.0%) cases the eustachian tube orifice was seen by the microscope through the perforation in the pars tensa, it was seen in 58(93.5%) cases by the otoendoscope (Table 4). Further granulations and edematous mucosa in the eustachian tube area are detected by the otoendoscope in more cases than with microscope (Table 4a). These findings are statistically significant with a p-value of <0.005


ET orifice(microscope)
n=3(16.7%)
n=15(83.3%)
normal
edematous

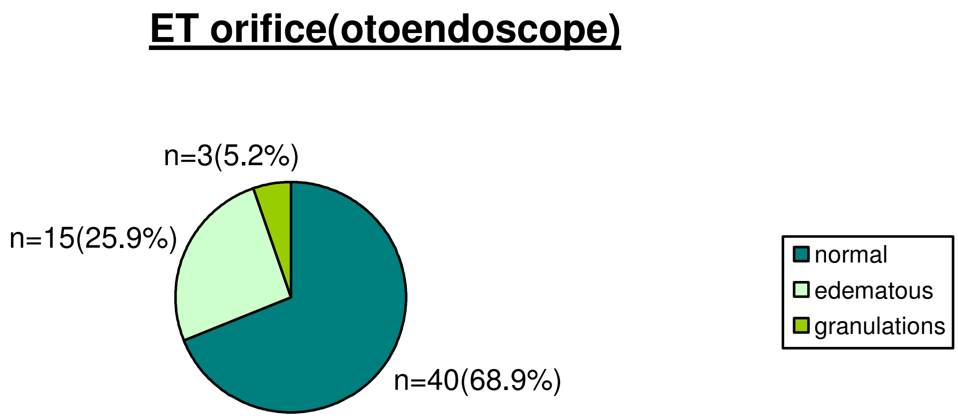
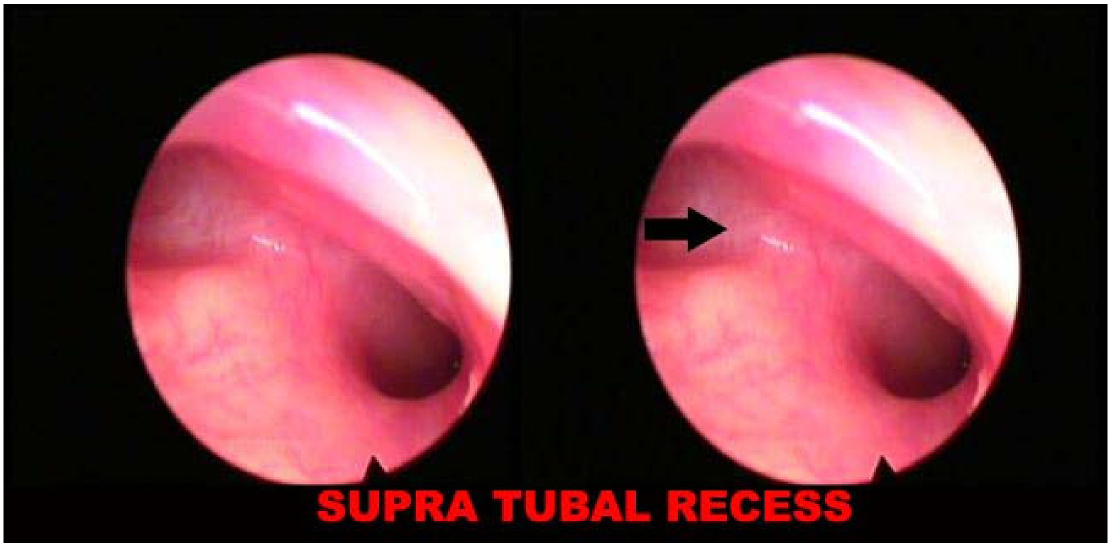

ET orifice(otoendoscope)
n=3(5.2%)
n=15(25.9%)
n=40(68.9%)
normal
edematous
granulations

Fig. 7a


SUPRA TUBAL RECESS

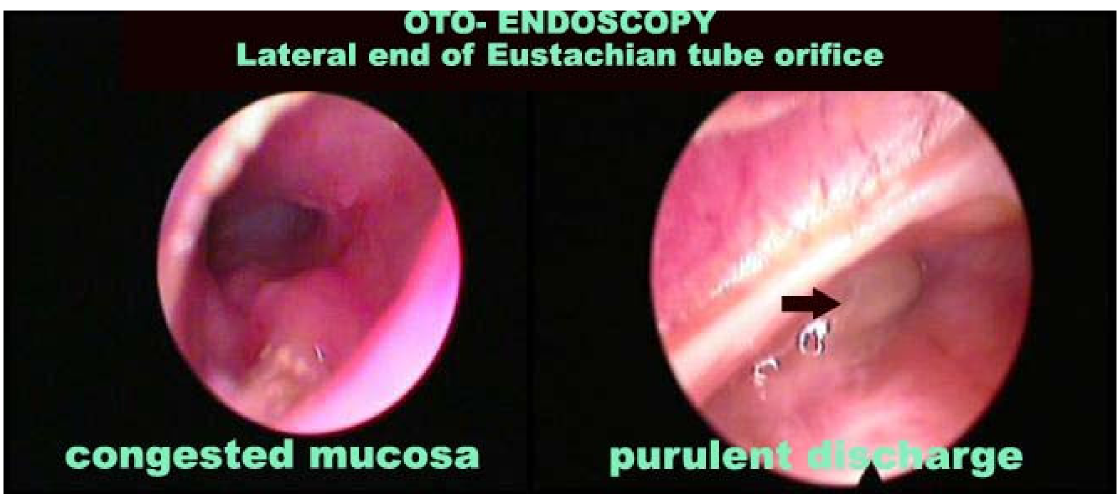

OTO- ENDOSCOPY
Lateral end of Eustachian tube orifice
congested mucosa
purulent discharge

Table 5 (Fig. 8)

Analysis of examination of protympanum

Protympanum	**Seen**	**Not Seen**
Microscope	15(24.2%)	47(75.8%)
Otoendoscope	46(74.2%)	16(25.8%)

p-0.000

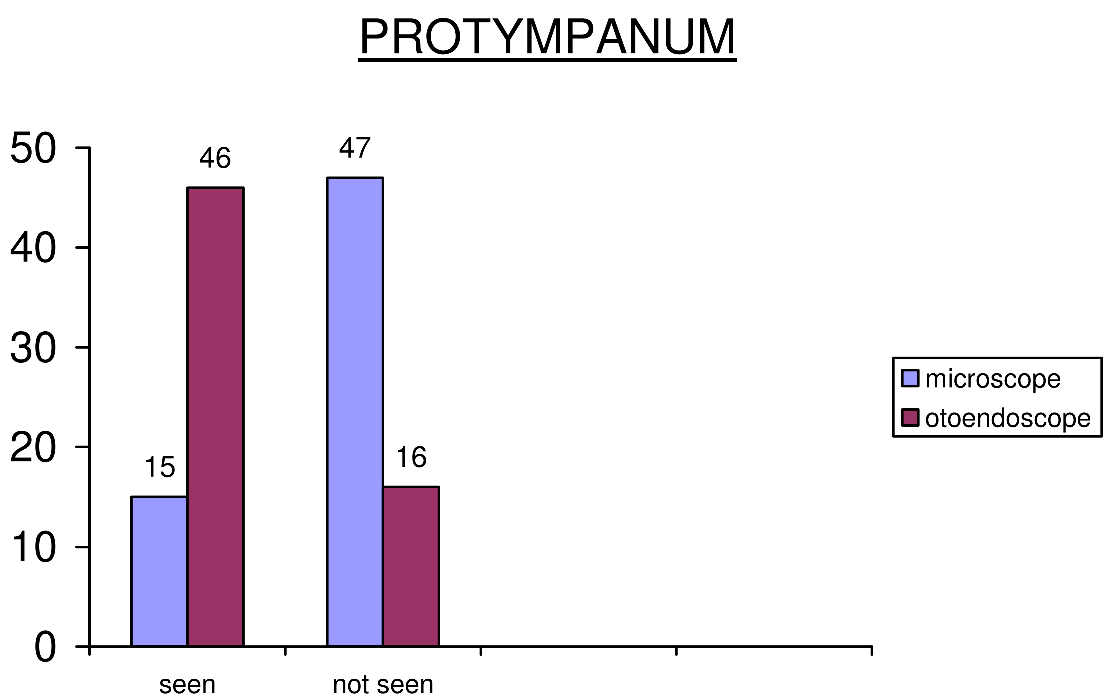

PROTYMPANUM
50
40
30
20
10
0
46
47
15
16
seen
not seen
microscope
otoendoscope

Fig. 8

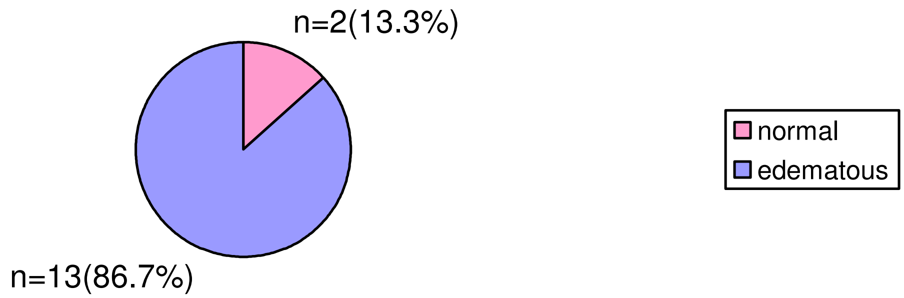
Table 5a (Fig. 8a)

Protympanum(Seen)	Normal	Edematous	Granulations
Microscope	13(86.7%)	2(13.3%)	
Otoendoscope	37(80.4%)	8(17.3%)	1(2.3%)

p-0.000

Similarly in the evaluation of the protympanum which is the anterior and around the eustachian tube orifice the otoendoscope was found to be more useful than the microscope both in identifying the anatomy(Table 5) and also in detecting the pathological findings such as edematous mucosa and granulations(Table 5a). The findings are statistically significant.

Protympanum(micoscope)



Protympanum(otoendoscope)

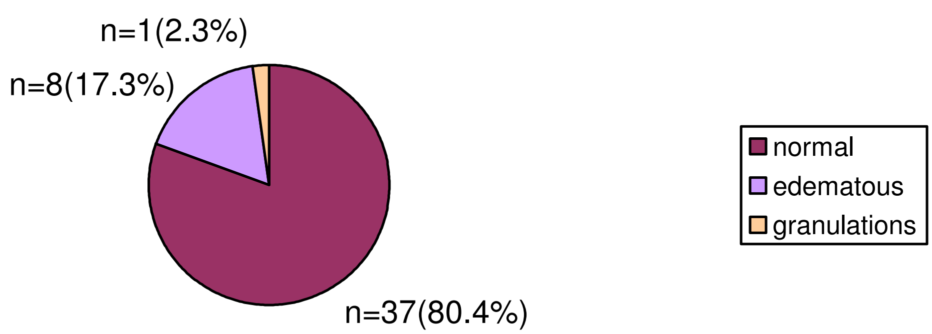


Fig. 8a

Table 6 (Fig. 9)

Analysis of examination of Hypotympanum

Hypotympanum	Seen	Not Seen
Microscope	16(25.8%)	58(93.5%)
otoendoscope	46(74.2%)	4(6.5%)

p-0.000

The hypotympanum can be often obscured from the view by the rim of the pars tensa perforation or a narrow canal. In this study while in only 16(25.8%) cases hypotympanum was visualized by microscope, in 58(93.5%) cases it was visualized by the otoendoscope (Table 6). This was possible as the endoscope could be rotated along the axis and visualize the hypotympanum. There is a statistically significant benefit with otoendoscope in assessing this parameter.

Table 7 (Fig. 10)

Analysis of examination of malleus

Malleus	Seen	Not seen
Microscope	55(88.7%)	7(11.3%)
Otoendoscope	60(96.8%)	2(3.2%)

p-0.163

HYPOTYMPANUM

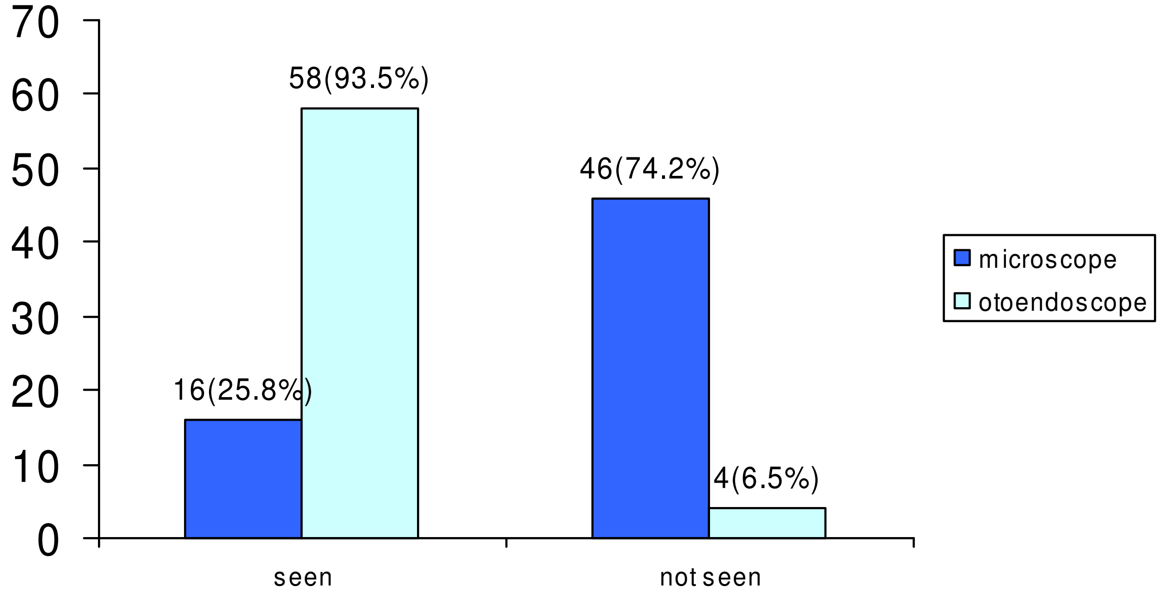


Fig 9

MALLEUS

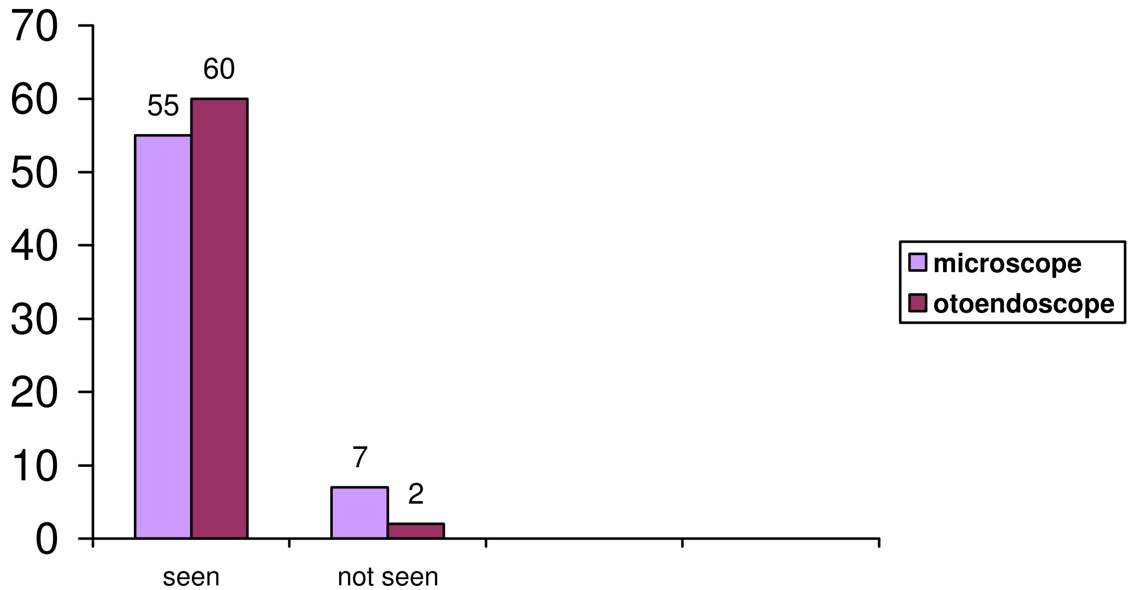


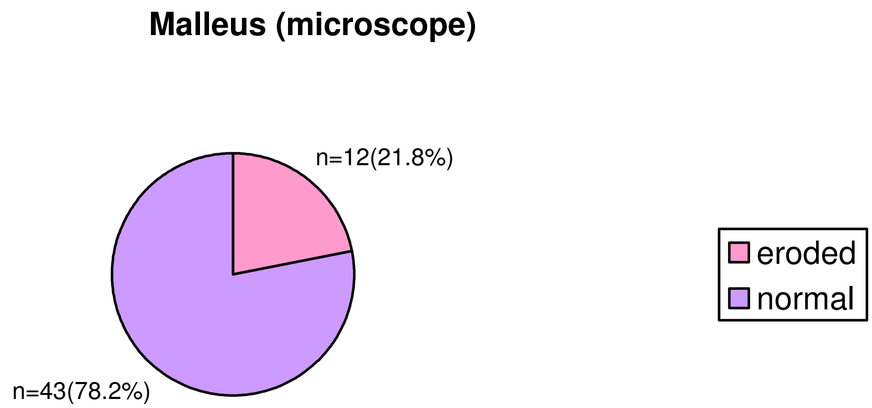
Fig. 10

HYPOTYMPANUM

Table 7a (Fig. 10a)

Malleus(seen)	**Normal**	**Eroded**
Microscope	43(78.2%)	12(21.8%)
Otoendoscope	46(76.6%)	14(23.4%)

p-0.140


Malleus (microscope)
n=12(21.8%)
n=43(78.2%)
eroded
normal

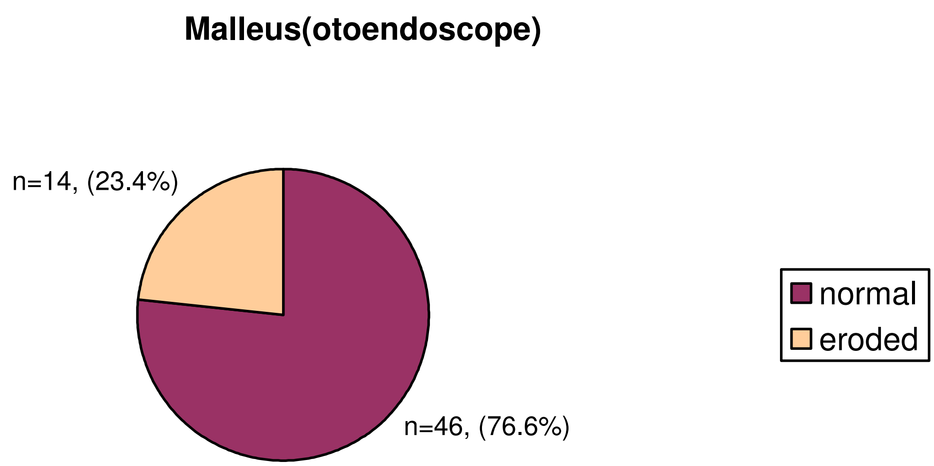

Malleus(otoendoscope)
n=14, (23.4%)
n=46, (76.6%)
normal
eroded

Fig. 10a

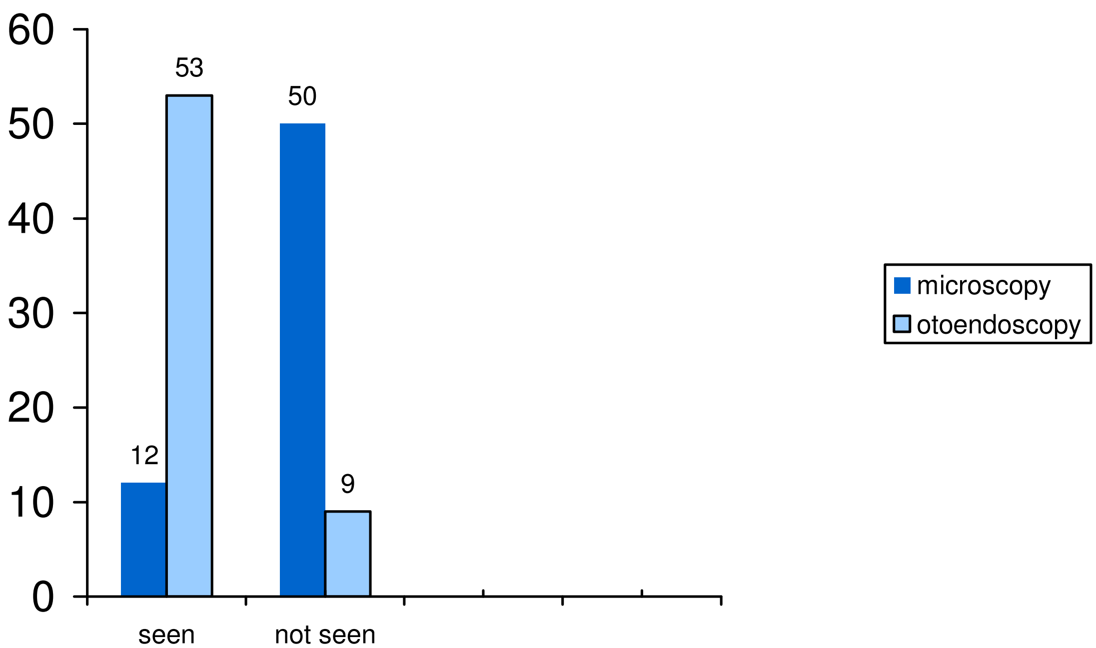
Table 8 (Fig. 11)

Analysis of examination of Incus

Incus	**Seen**	**Not seen**
Microscope	12(19.4%)	50(80.6%)
Otoendoscope	53(85.5%)	9(14.5%)

p-0.000

INCUS



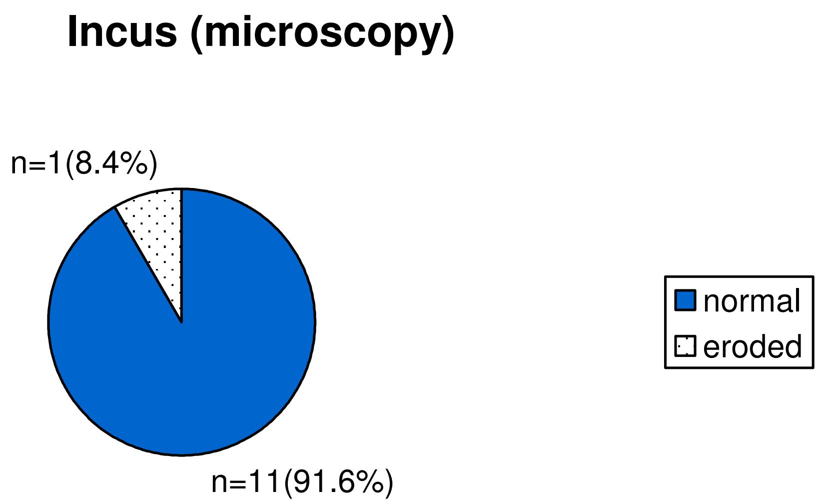
60
50
40
30
20
10
0
53
50
12
9
seen
not seen
microscopy
otoendoscopy

Fig.11

Table 8a (Fig. 11a)

Incus(seen)	**Normal**	**Eroded**
Microscope	11(91.6%)	1(8.4%)
Otoendoscope	47(88.7%)	6(11.3%)

p-0.000


Incus (microscopy)
n=1(8.4%)
n=11(91.6%)
normal
eroded

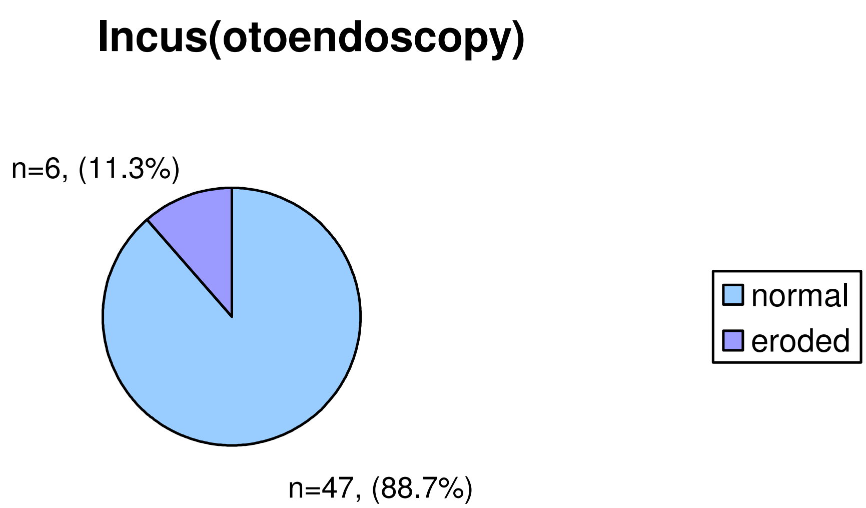

Incus(otoendoscopy)
n=6, (11.3%)
n=47, (88.7%)
normal
eroded

Fig. 11a

Table 9 (Fig. 12)

Analysis of examination of stapes

Stapes	**Seen**	**Not Seen**
Microscope	9(14.5%)	53(85.5%)
Otoendoscope	48(77.4%)	14(22.6%)

p-0.000

The examination of ossicles in this study revealed that while there is no added benefit by otoendoscopy in assessing the malleus over the microscope (Table 7; p-value>0.05), there is a definite benefit of otoendoscope in visualizing the incus (Table 8,8a) and stapes (Table 9) and their abnormalities. The difference is statistically significant in visualizing the incus and stapes (p<0.005).

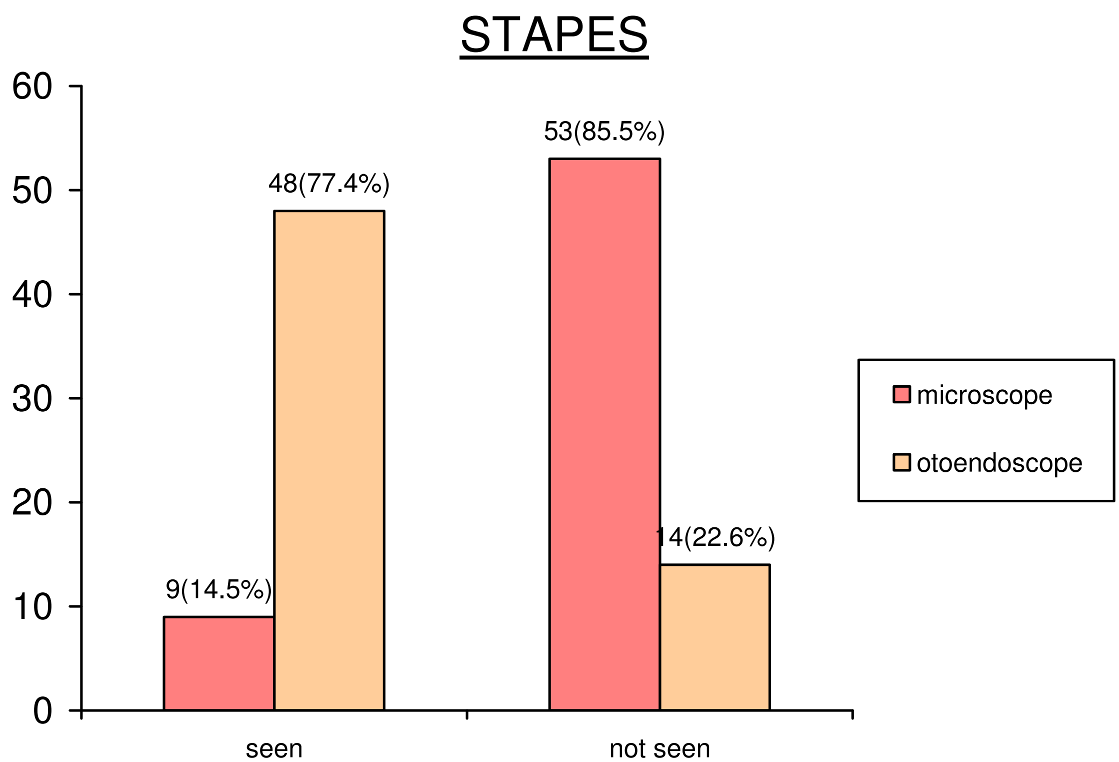

STAPES
60
50
40
30
20
10
0
48(77.4%)
53(85.5%)
9(14.5%)
14(22.6%)
seen
not seen
microscope
otoendoscope

Fig. 12

Table 10 (Fig. 13)

Analysis of examination of Incudostapedial joint

Incudostapedial joint	**Seen**	**Not Seen**
Microscope	9(14.5%)	53(85.5%)
Otoendoscope	50(80.6%)	12(19.4%)

p-0.000

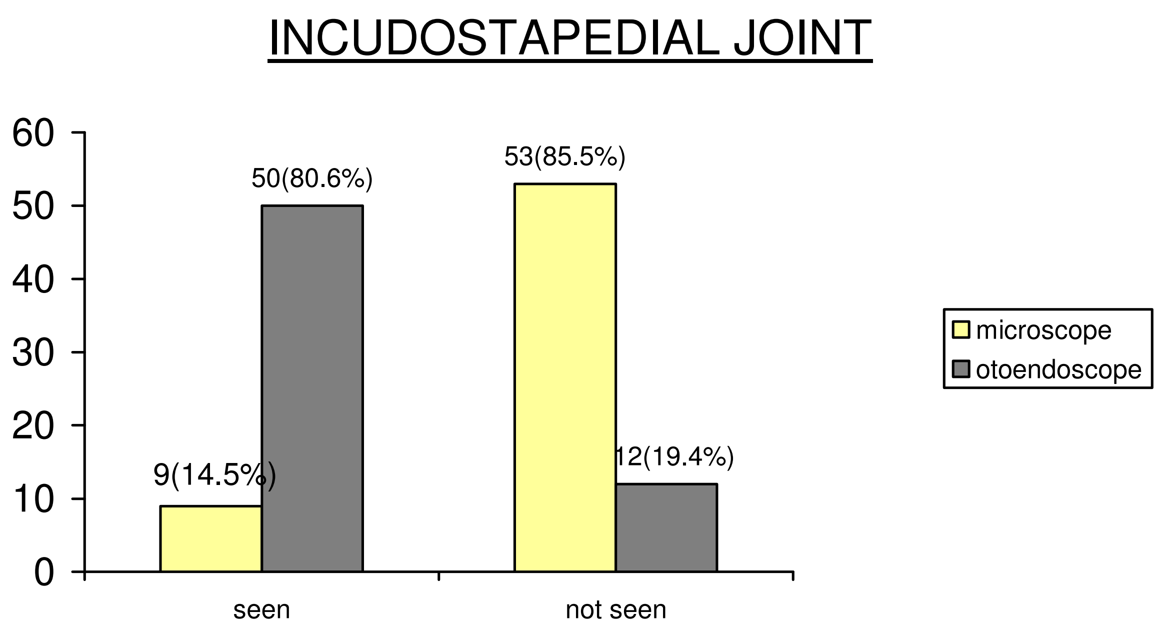
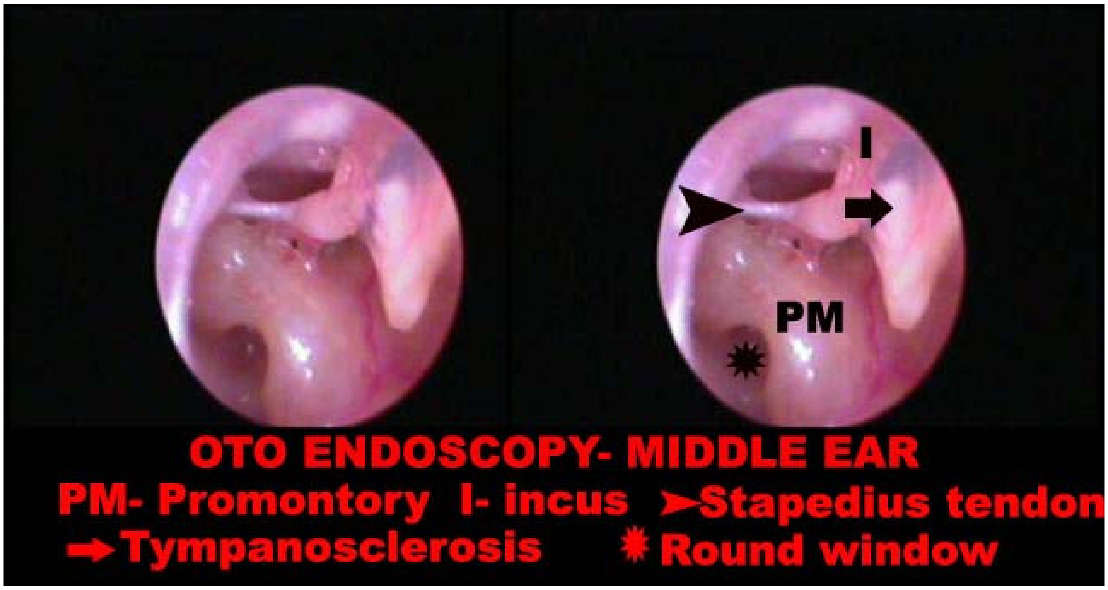

INCUDOSTAPEDIAL JOINT
60
50
40
30
20
10
0
50(80.6%)
53(85.5%)
9(14.5%)
12(19.4%)
seen
not seen
microscope
otoendoscope

Fig. 13


I
PM
OTO ENDOSCOPY- MIDDLE EAR
PM- Promontory I- incus Stapedius tendon
Tympanosclerosis Round window

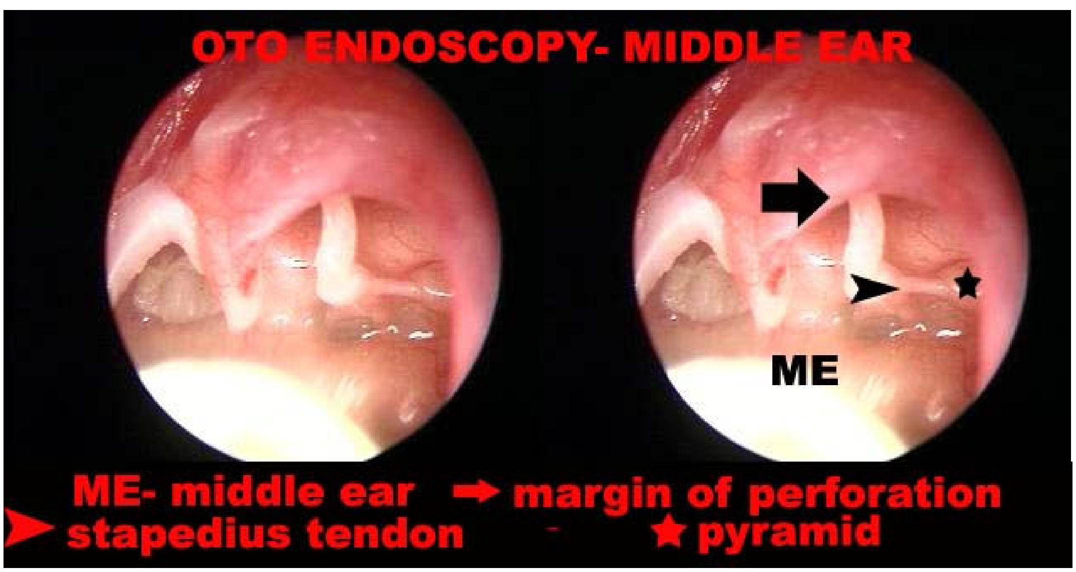

OTO ENDOSCOPY- MIDDLE EAR
ME
ME- middle ear margin of perforation
stapedius tendon pyramid

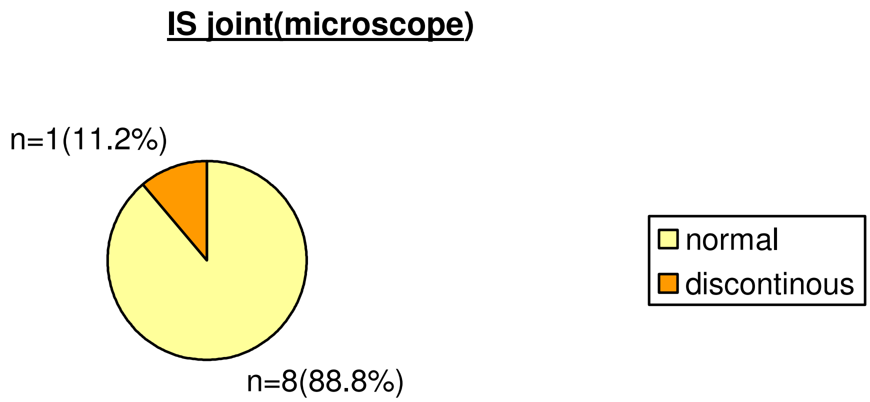
Table 11 (fig. 13a)

IS Joint(seen)	**Normal**	**Discontinous**
Microscope	8(88.8%)	1(11.2%)
otoendoscope	42(84.0%)	8(16.0%)

p-0.000

In visualizing the incudostapedial joint the otoendoscopes have a definite advantage over microscope due to the angled view. This is also demonstrated in this study where in 50 cases(80.6%) out of the 62 the joint could be visualized using the otoendoscope while only in 9 cases(14.5%) the IS joint could be visualized by microscope.

Also the discontinuity of Incudostapedial joint was picked up by otoendoscope in 8 cases while there was 1 case by microscope.


IS joint(microscope)
n=1(11.2%)
n=8(88.8%)
normal
discontinous

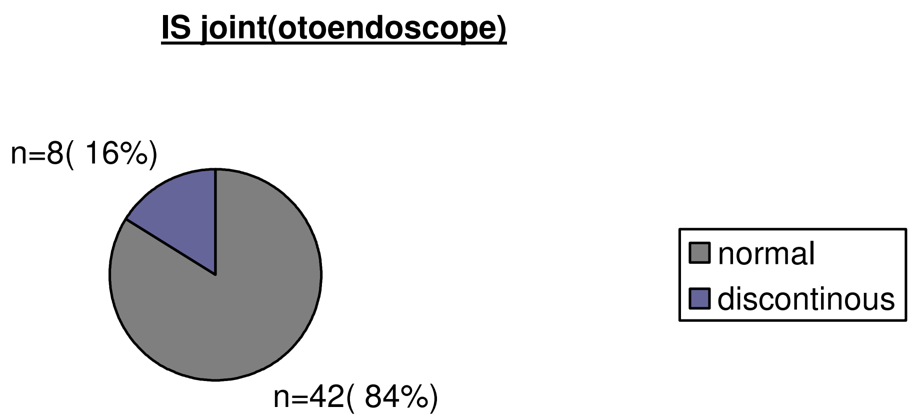

IS joint(otoendoscope)
n=8(16%)
n=42(84%)
normal
discontinous

Fig. 13a

Table 12 (Fig. 14)

Analysis of examination of Ossicular chain mobility

Ossicular chain mobility	Unable to assess	Assessed
Microscope	62(100.0%)	0(0%)
Otoendoscope	23(37.9%)	39(62.1%)

p-0.000

Table 12a (Fig. 14a)

Oss.chain mobility(seen)	Mobile	Not Mobile
Otoendoscopy	31(79.0%)	8(21.0%)

p-0.000

The ossicular chain mobility is an important factor to consider in achieving a good outcome. Hence assessment of the chain mobility is an important part of the examination pre-operatively. In our study it was found that while the mobility of ossicular chain by microscopy in all the cases was not checked, owing to inability to visualize ossicular chain through anterior or small perforations, patient discomfort, etc., it was possible to assess the mobility in 39 cases using the otoendoscopy. Out of these 39 cases, discontinuity was found in 8(21.0%) cases. This finding is statistically significant. Though the round window was clearly visible in several cases by otoendoscopy and few cases by microscopy evaluation of the reflex with a drop of saline was cumbersome to perform and hence was not considered in the study.

OSSICULAR CHAIN MOBILITY

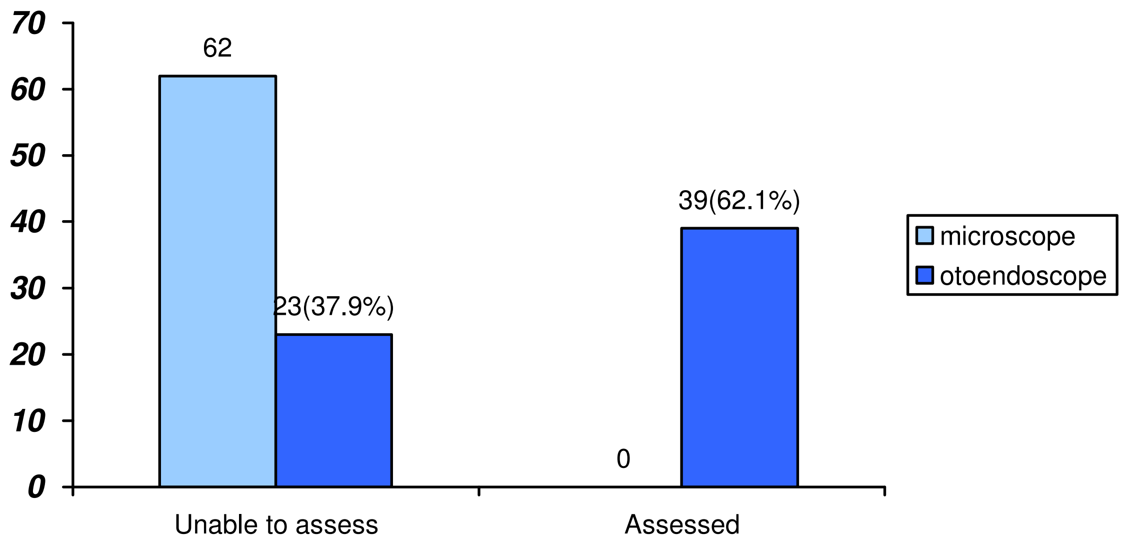


Fig. 14

Ossicular chain mobility(seen)

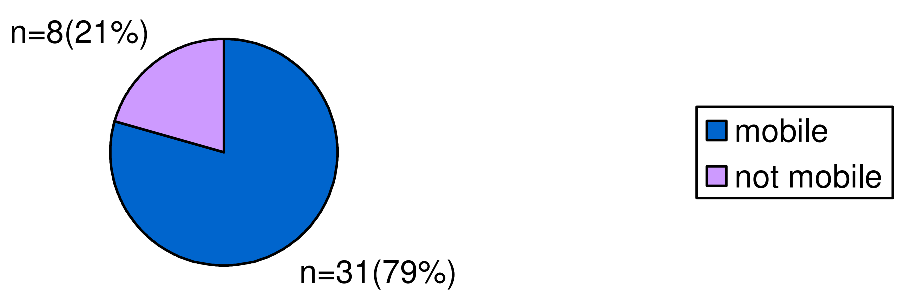


Fig. 14a

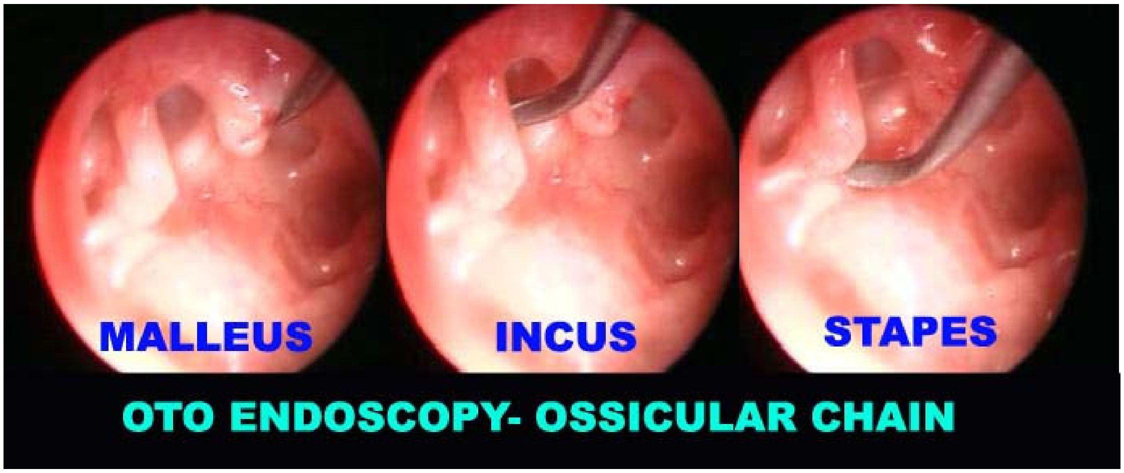

MALLEUS
INCUS
STAPES
OTO ENDOSCOPY- OSSICULAR CHAIN

Table 13 (Fig.15)

Estimation of presence of tympanosclerosis

Tympanosclerosis	Present	Absent
Microscopy	3(4.8%)	59(95.2%)
Otoendoscopy	5(8.1%)	57(91.9%)

p-0.717

There were only few cases of tympanosclerosis seen in this study among the cases. There were not enough cases to assess a significant difference in the use of otoendoscope over microscope in this parameter. The statistical insignificance was shown by the p-0.717

Table 14 (Fig. 16)

Analysis of examination of sinus tympanum

Sinus tympnum	Seen	Not seen
Microscopy	7(11.3%)	55(88.7%)
Otoendoscopy	39(62.9%)	23(37.1%)

p-0.000

In visualizing the sinus tympanum the otoendoscopy was superior to microscopy. Out of the 62 cases sinus tympanum was visualized in 39(62.9%) cases by otoendoscopy whereas only 7(11.3%) sinus tympanii could be visualized by microscopy through perforations. However none of the sinus tympanii visualized had any hidden disease. The p-value is <0.005 which is statistically significant.

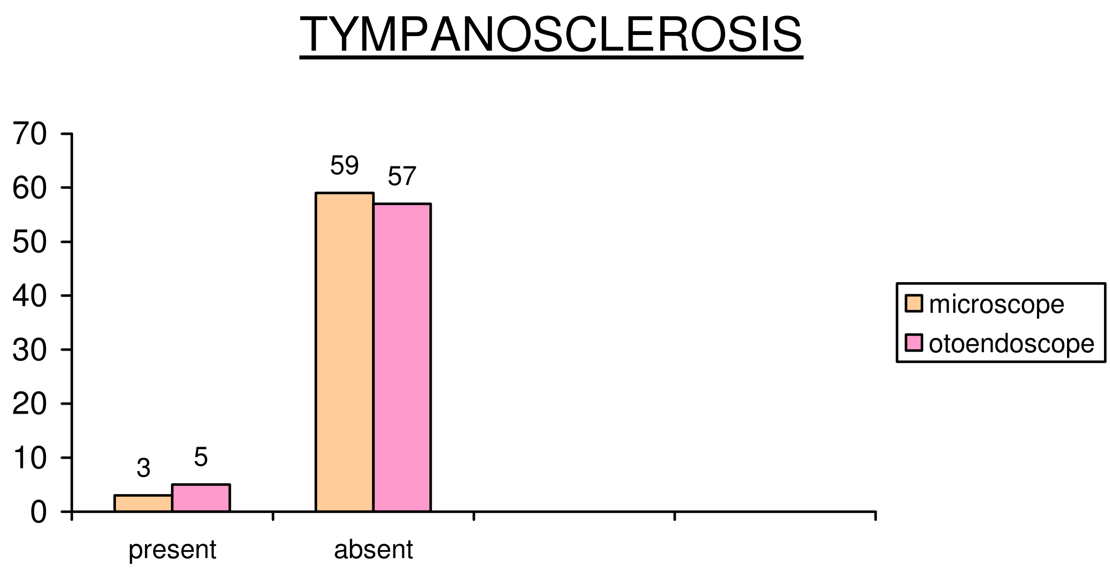

TYMPANOSCLEROSIS
70
60
50
40
30
20
10
0
3
5
59
57
present
absent
microscope
otoendoscope

Fig. 15

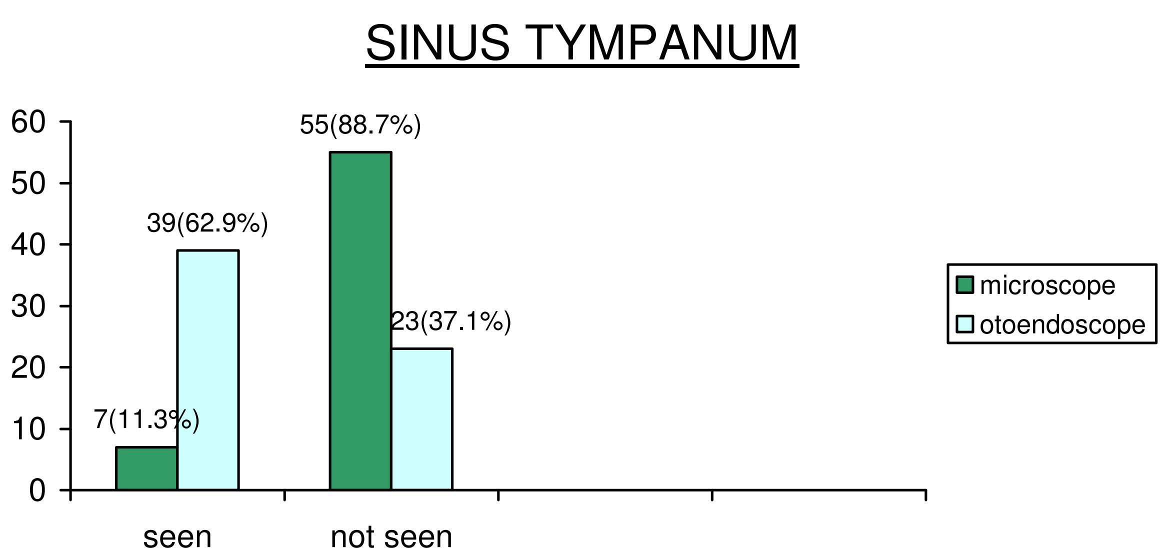

SINUS TYMPANUM
60
50
40
30
20
10
0
7(11.3%)
39(62.9%)
55(88.7%)
23(37.1%)
seen
not seen
microscope
otoendoscope

Fig. 16

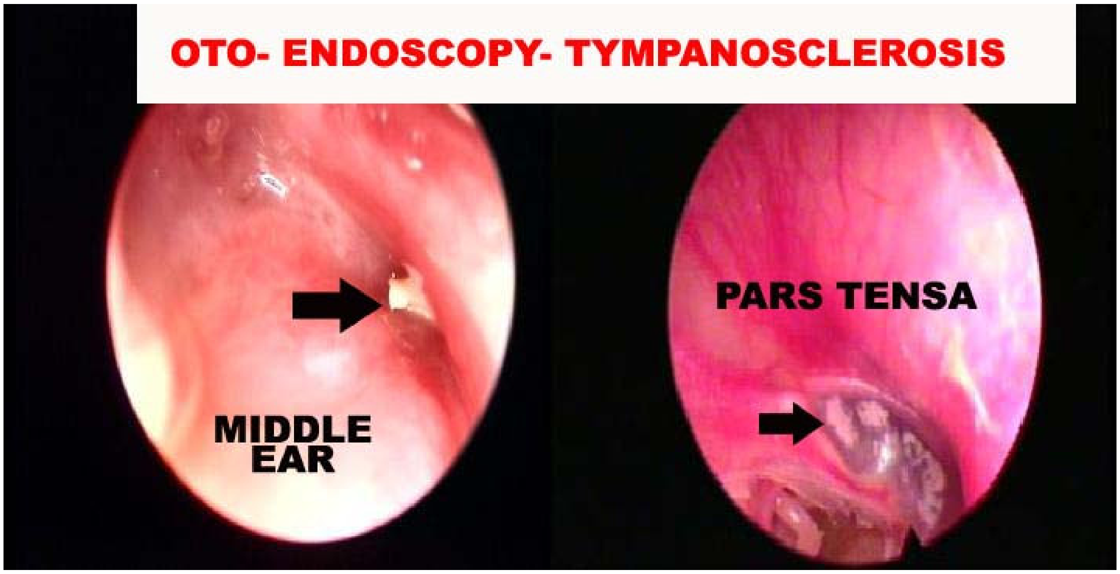

OTO- ENDOSCOPY- TYMPANOSCLEROSIS
MIDDLE EAR
PARS TENSA

Table 15 (Fig. 17)

Presence of hidden cholesteatoma

Sec. acq.cholesteatoma	**Present**	**Absent**
Microscope	0(0%)	62(100.0%)
Otoendoscope	2(3.2%)	60((96.8%)

p-0.496

In this study we had an incidental finding of secondary acquired cholesteatoma in 2 cases both of which were detected by the use of otoendoscope. This finding changed the surgical intervention that was planned earlier. However this difference is not statistically significant.

Secondary acquired cholesteatoma

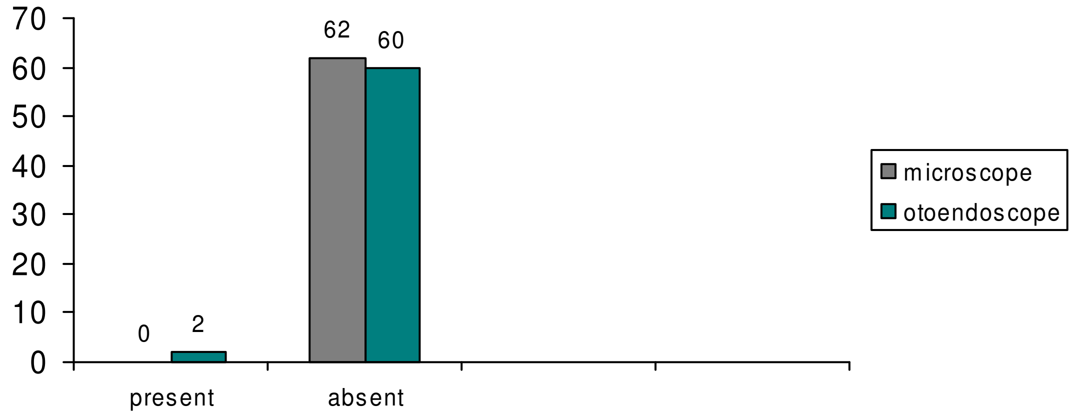


Fig. 17

DISCUSSION

As per the World Health Organization's report- "Chronic Suppurative Otitis Media Burden of Illness and management options", Geneva, Switzerland 2004 by Dr Jose Acuin, Philippines, [13] India is placed among few other nations where the prevalence of Chronic Suppurative Otitis Media is greater than 4%. Chronic Suppurative Otitis Media as a disease is a common entity in most of the ENT clinics in our country. Hearing disability caused by tympanic membrane perforation and ossicular pathology, in tubotympanic disease are almost always correctable.

The microscope has revolutionized the treatment and diagnosis of Chronic Suppurative Otitis Media [14]. However due to its limited range of field of vision the surgeon may often be left with no other option but to leave the complete evaluation of the middle ear till the patient undergoes surgery when after the elevation of the flap the middle ear is better visualized. This is especially true while the ossicular chain status is being evaluated. Inability to see and evaluate the mobility of ossicular chain may lead the surgeon to explain the hearing benefits to the patient incorrectly and only based on the audiogram findings.

The introduction of rod endoscopes in the field of surgery including in ENT has improved the diagnostic ability and in turn the surgical outcome. The use of rod endoscopes in nasal disease evaluation and surgical intervention is very remarkable. Due to the angled vision it provides, the deeper recesses of any cavity are clearly visualized [15] .This advantage has been utilized well in nasal surgeries [16]. Otoendoscopy as an additional tool in the evaluation of middle ear has been used by surgeons world wide but much of this use has been limited to atticoantral disease because of the concern to the adverse effects of a residual disease [7,17,18] . Thomassin [6], Yung [19], Mckennan [5], Tarabichi, [18] etc., have demonstrated quite convincingly the need of otoendoscopy for post op assessment of residual disease in cholesteatoma surgery.

A pre-operative assessment of middle ear in a tubotympanic disease not only gives the surgeon an idea of the status of the middle ear but also helps him to explain to the patient the different outcomes of a surgery in regard to the chance of recurrence and hearing improvement etc.

In our study, the examination of external auditory canal and evaluation of the size of perforation of the pars tensa has shown almost similar results by both microscopy and otoendoscopy. The p-value for this parameter of study was greater than 0.05(table 1 & 2)) indicating that there is no statistically significant difference between microscope and otoendoscope in the evaluation of both external auditory canal and pars tensa indicating that both are equally good in the assessment of External auditory canal. The lack of any advantage of the otoendoscopy in these two parameters is probably because the external auditory canal and pars tensa are not hidden areas of the ear.

However, in the evaluation of middle ear mucosa it was possible to detect edematous mucosa in only 11(17.7%) of cases by microscopy whereas

24(38.7%) cases of edematous middle ear mucosa were detected by otoendoscopy. The eustachian tube area is only occasionally seen through the microscope. In this study while in only 18(29.0%) cases the eustachian tube orifice was seen by the microscope through the perforation in the pars tensa, it was seen in 58(93.5%) cases by the otoendoscope (Table 4). Further granulations and edematous mucosa in the eustachian tube area are better detected by the otoendoscope with microscope (Table 4a). Similarly in the evaluation of the protympanum otoendoscope was found to be more useful than the microscope both in identifying the anatomy (Table 5) and also in detecting the pathological findings such as edematous mucosa and granulations (Table 5a). The hypotympanum was visualized in only 16(25.8%) cases by microscope, whereas in 58(93.5%) cases it was visualized by the otoendoscope (Table 6). Hence there is a statistically significant benefit with otoendoscope in assessing middle ear mucosa, the eustachian tube, protympanum, hypotympanum. The 30^0 2.7mm endoscope has provided valuable information especially regarding the eustachian tube orifice, the protympanum, hypotympanum, and the sinus tympanum and the $45\ ^0$ 4.0mm endoscope has provided valuable information regarding the ossicular chain.

The examination of ossicles in this study revealed that while there is no added benefit by otoendoscopy in assessing the malleus over the microscope (Table 7; p-value>0.05), there is a definite benefit of otoendoscope in visualizing the incus (Table 8,8a) and stapes (Table 9) and their abnormalities. In visualizing the IS joint the otoendoscope has a definite advantage over microscope due to the angled view. This is also demonstrated in this study where in 50 cases (80.6%) out of the 62 the Incudostapedial joint could be visualized using the otoendoscope while only in 9 cases(14.5%) the Incudostapedial joint could be visualized by microscope. Also the discontinuity of the Incudostapedial joint was picked up by otoendoscope in 8 cases while there was 1 case by microscope. Thus in our study with use of 45^0 endoscope the individual ossicles and the ossicular chain status could be verified. This could be done with ease in any perforation greater than 3mm approximately. Though greater number of our study patients underwent the procedure under GA it can be done without any anesthesia in the OPD setting without much problem. The video demonstration and recordings are also useful for detailed analysis at a later time. By demonstrating the ossicular status pre-operatively a patient could be explained the outcomes to expect from the surgery.

Though it was not statistically significant in our study, findings like hidden cholesteatoma and ossicular / middle ear tympanosclerosis etc, which are not detected by microscopy, could be detected by otoendoscopy. This advantage with otoendoscope could allow the surgeon to make a plan pre-operatively and also to expect the possible outcome.

Though it was not observed in this study, facial nerve anomalies such as dehiscent fallopian canal or overhanging facial nerve over the stapes may also be detected when it is present. Prior detection of any such anomaly could allow the surgeon to be cautious while accessing these areas.

Another advantage of endoscopes over the microscopes is the cost of equipment involved and handling. Whereas the microscopes need expert maintenance and are expensive to buy, the otoendoscope which have many more advantages cost only a fraction of amount that a microscope costs. The endoscopes have a greater advantage in handling over microscopes especially when in use with mobile clinics or in bedside examinations for sick patients.

CONCLUSION

Otomicroscopy is well established for evaluation of structural abnormalities of external auditory canal, tympanic membrane and malleus. However it is inadequate for complete evaluation of middle ear structures as incus, stapes, incudostapedial joint, eustachian tube orifice, protympanum, hypotympanum, and sinus tympani.

Otoendoscopy is superior and valuable as a diagnostic tool in assessing

- the Incus and Stapes,
- the Incudostapedial joint,
- the ossicular chain mobility,
- middle ear mucosa,

as well as evaluating the hidden areas of middle ear such as eustachian tube area, protympanum, hypotympanum, sinus tympanum and detecting middle ear tympanosclerosis, hidden cholesteatoma etc that can be missed by microscopy.

Pre-operative otoendoscopic work up is recommended for complete evaluation of patients with Chronic Suppurative Otitis Media-tubotympanic disease

BIBLIOGRAPHY

1. Tarabichi M. Endoscopic middle ear surgery. Annals of Otology Rhinology Laryngology. 1999;108:39-46
2. Hawke M. Telescopic otoscopy and photography of the tympanic membrane. Journal of Otolaryngology. 1982; 11:35-9.
3. Takahashi H, Honjo r, Fujita A. Trans tympanic endoscopic findings in patients with otitis media with effusion. Archives Otolaryngology Head Neck Surgery. 1990; 116: 1186-89
4. Poe DS, Bottrill D. Comparison of endoscopic and surgical explorations for perilymphatic Fistulas. American Journal of Otology. 1994; 15:735-8
5. McKennan K. Endoscopic "second look" mastoid cavity to rule out residual epitympanic/ mastoid cholesteatoma. Laryngoscope. 1993; 103:810-4.
6. Thomassin JM. Korchia O, Doris JM. Endoscopic-guided otosurgery in the prevention of residual cholesteatomas. Laryngoscope. 1993: 103:939:43.
7. El Meselaty K, Badr El Dine M, Mandour M, Mourad M, Darweesh R. Otoendoscopically Guided Surgery. American Journal of Otology. 17(3):499-500, May 1996.
8. Rinaldo canalis, Paul Lambert. The Ear Comprehensive Otology. Lippincott Williams and wilkins Inc. 1990; 1st edition.
9. Anson B J, Bast T H 1946.The development of the auditory ossicles and associated structures in man. Annals of Otology. 55: 467-494

10. Harold Ludman and Tony wright Diseases of the ear. Oxford University press Inc. 6th edition.374-438

11. Friedmann T, Arnold W. Pathology of the ear. Churchill Livingstone. 1st edition. 1993; 80-86

12. Glasscock M, Shambaugh G Jr. Surgery of the ear. 1990 W.B. Saunders Co. 4th edition. 351-359

13. Jose Acuin. Chronic suppurative otitis media, Burden of Illness and Management Options. World Health Organization, Geneva,Switzerland 2004.

14. Dworacek H. The anatomical relationship of the middle ear under the operating microscope. Acta Otolaryngolica. 1960;51: 15-45

15. Fatthi Abdel Baki, Mohammed Badr el dine, Ibrahim El Saiid, Moustafa Bakry. Sinus tympani endoscopic anatomy. Otolaryngology Head and Neck Surgery. Vol 127 No.3

16. Kennedy DW: Functional endoscopic sinus surgery: Technique. Arch otolaryngology head Neck Surg. 1985;111:643-649

17. M.Badr El Dine. Value of ear endoscopy in cholesteatoma surgery. Otology and Neurotology. 2002; 23:631-35

18. Tarabichi M. Endoscopic management of acquired cholesteatoma. American journal of Otology. 1997; 18:544-9.

19. YYung MM. The use rigid endoscopes in cholesteatoma surgery. Journal of Laryngology Otology. 1994; 307-9.

20. Rosenberg SI. Endoscopic otologic surgery. Otolaryngology Clinics North Am. 1996; April 29(2):291-300.

21. Bowdler DA, Walsh RM. Comparison of the otoendoscopic and microscopic anatomy of the middle ear cleft in canal wall-up and canal wall-down temporal bone dissection. Clinical Otolaryngology. 1995;20:418-22

22. Charles Cummings, Otolaryngology Head and Neck Surgery. Elsevier Mosby. 4th edition; Volume 3: 133-137

23. Nomura Y. Effective photography in otolaryngology head and neck surgery: endoscopic photography of the middle ear. Otolaryngology Head Neck Surgery 1982; 90:395-8.

24. Palva T, Ramsay H. Endoscopy of the middle ear. American Journal of otology. 2000; March 21(2): 288-9

25. Rosenberg sr, Silverstein H, Willcox T.O. Endoscopy otology and neurotology. American Journal of Otology.1994; 15:168-729.

26. Thomassin JM, Braccini F. Role of imaging and endoscopy in the follow up and management of cholesteatomas operated by closed technique. Rev Laryngol Otol Rhinol. 1999; 75-81

27. Youssef T, Poe OS. Endoscope-assisted 2nd-stage tympanomastoidectomy. Larynngoscope.1997; 107: I :341-4.

APPENDIX

PROFORMA

PRE-OPERATIVE OTOENDOSCOPY EVALUATION OF SAFE TYPE OF CSOM PROFORMA I

I. Identification:

A: Name- C: Hospital No-

B: Age/ Sex- D: Study no-

II. Diagnosis:

A. Right CSOM TTD i) active ii) inactive

B. Left CSOM TTD i) active ii) inactive

C. BILATERAL CSOM TTD i) active ii) inactive

III Examination done by:

A. MICROSCOPIC EXAMINATION	Right	Left
i. Ext auditory canal 1)Normal 2) Narrow 3)Tortuous		
ii. Perforation 1)Small 2)Moderate 3)Large 4)Subtotal		
iii.M.E.mucosa 1)Normal 2)Congested 3) edematous 4) polypoidal		
iv.E.T. orifice 1)Normal 2)Edematous 3)Granulations 4) Not seen		
v. Protympanum 1)Normal 2)Oedematous 3)Granulations 4) Not seen		
vi.Hypotympaum 1)seen 2)Not Seen		
vii. Malleus 1)Seen 2)Not seen If Seen 1)Normal 2)Partially eroded 3)Fully eroded		
viii.Incus 1)Seen 2)Not seen If Seen 1)Normal 2)Partially eroded3)Fully eroded		
ix.Stapes 1)Seen 2)Not seen If Seen 1)Normal 2)Partially eroded3)Fully eroded		
x.Ossicular Chain a.Status 1)seen 2)Not Seen xi.If seen 1)Normal 2)discontinuous		
xii.Mobility 1)Not assessed 2)Assessed if 2) a)Mobile b)Fixed		
xiii.Tympanosclerosis 1)present 2) absent		
xiv.Sinus tympani 1)Not seen 2)Seen		
xv.Secondary acquired cholesteatoma 0)Absent 1)Present		

IV Audiogram:

V Surgery Planned :

PRE-OPERATIVE OTOENDOSCOPY
EVALUATION OF SAFE TYPE OF CSOM
PROFORMA II

A: Name- C: Hospital No-

B: Age/ Sex- D: Study no-

III Examination done by:

B. OTOENDOSCOPIC EXAMINATION	Right	Left
i. Ext auditory canal 1)Normal 2) Narrow 3)Tortuous		
ii. Perforation 1)Small 2)Moderate 3)Large 4)Subtotal		
iii.M.E.mucosa 1)Normal 2)Congested 3) edematous 4) polypoidal		
iv.E.T. orifice 1)Normal 2)Edematous 3)Granulations 4) Not seen		
v. Protympanum 1)Normal 2)Oedematous 3)Granulations 4) Not seen		
vi.Hypotympaum 1)seen 2)Not Seen		
vii. Malleus 1)Seen 2)Not seen If Seen 1)Normal 2)Partially eroded 3)Fully eroded		
viii.Incus 1)Seen 2)Not seen If Seen 1)Normal 2)Partially eroded3)Fully eroded		
ix.Stapes 1)Seen 2)Not seen If Seen 1)Normal 2)Partially eroded3)Fully eroded		
x.Ossicular Chain a.Status 1)seen 2)Not Seen xi.If seen 1)Normal 2)discontinuous		
xii.Mobility 1)Not assessed 2)Assessed if 2) a)Mobile b)Fixed		
xiii.Tympanosclerosis 1)present 2) absent		
xiv.Sinus tympani 1)Not seen 2)Seen		
xv.Secondary acquired cholesteatoma 0)Absent 1)Present		

VI Surgery Performed :

SNO	HOS_NO	AGE	SEX	SIDE	ACTIVE	GROUP	ME1	ME2	ME3	ME4	ME5	ME6	ME7	ME7A	ME8	ME8A	ME9	ME9A	ME10	ME11	ME12	ME13	ME14	ME15	OTO1	OTO2	OTO3	OTO4	OTO5	OTO6	OTO7	OTO7A	OTO8	OTO8A	OTO9	OTO9A	OTO10	OTO11	OTO12	OTO13	OTO14	OTO15
1	723912C	38	1	1	2	1	1	4	2	4	4	2	1	1	2		2		3	1	3	2	1	1	1	3	1	1	1	1	1		1	2	1	1	1	1	3	2	2	1
2	162908B	14	1	1	2	1	1	3	1	4	4	2	1	1	2		2		3	1	3	2	1	1	1	2	3	1	1	1	1	1	1	1	1	1	1	2	3	2	2	1
3	740504C	36	1	2	2	1	1	2	1	1	4	2	1	1	2		2		3	1	3	2	1	1	1	3	1	1	1	1	1	1	1	1	1	1	1	2	1	2	2	1
4	616788C	28	1	1	1	1	1	3	1	4	4	1	1	1	2		2		3	1	3	2	1	1	1	3	1	4	4	1	1	1	1	1	1	1	2	2	3	2	2	1
5	749643C	29	2	1	1	1	1	2	1	4	4	2	1	1	2		2		3	1	3	2	1	1	1	2	3	1	4	1	1	1	1	1	1	1	2	1	3	2	1	1
6	682624C	22	1	1	2	1	1	2	1	4	4	2	1	1	2		2		3	1	3	1	1	1	1	3	1	1	1	1	1	1	1	1	1	1	1	2	3	1	2	1
7	785834C	43	2	2	2	1	1	2	1	4	4	2	1	1	2		2		3	1	3	2	1	1	1	2	1	1	1	1	1		1	2	1	1	2	2	2	2	2	1
8	500048C	25	1	1	2	1	1	3	2	4	4	2	1	1	2		2		3	1	3	2	1	1	1	3	3	2	1	1	1	1	1	1	1	1		2	1	2	2	1
9	511216C	42	2	1	2	1	1	3	1	4	4	2	1	1	1	1	2		3	1	3	2	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1	2	1	2	2	1
10	684727C	50	2	1	1	1	1	3	3	4	4	2	1	1	2		2		3	1	3	2	1	1	1	3	3	2	2	1	1	1	1	1	2		3	1	3	2	2	1
11	469527C	46	1	2	1	1	1	3	2	1	4	2	1	2	2		2		3	1	3	2	1	1	1	4	1	1	1	1	1	2	1	2	1	1	2	1	3	2	2	1
12	223768C	48	1	1	1	1	1	3	1	4	4	2	1	1	2		2		3	1	3	2	1	1	1	3	1	1	1	1	1	1	2		2		3	1	3	1	1	1
13	780298C	17	1	1	2	1	1	1	1	4	4	2	1	1	2		2		3	1	3	2	1	1	1	1	1	2	4	2	1	1	2		2		3	1	3	2	1	1
14	780298C	17	1	2	2	1	1	3	1	1	4	1	1	1	2		2		3	1	3	2	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1	2	1	2	2	1
15	728908C	17	2	2	2	1	1	2	1	4	4	2	1	1	2		2		3	1	3	1	1	1	1	2	1	1	1	1	1	1	1	1	1	1		2	1	1	1	1
16	873989A	33	2	1	1	1	1	2	3	4	4	2	1	1	2		2		3	1	3	2	1	1	1	3	3	2	4	1	1	1	1	2	1	1		2	3	2	2	1
17	797860C	28	1	2	2	1	1	1	1	4	4	2	1	1	1	1	1	1	1	1	3	2	2	1	1	2	1	1	4	1	1	1	1	1	1	1	1	2	3	2	2	1
18	799571C	31	1	1	2	1	1	2	1	4	4	2	1	1	2		2		3	1	3	2	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1	2	1	2	2	1
19	774671C	48	1	1	1	1	1	2	2	2	4	2	1	1	2		2		3	1	3	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	3	2	2	1
20	412376C	38	1	2	2	1	1	4	1	1	1	1	1	2	1	1	1	1	1	1	3	2	2	1	1	4	1	1	1	1	1	2	1	1	1	1	1	2	1	2	2	1
21	865833C	28	2	1	1	1	1	4	2	4	4	2	2		2		2		3	1	3	2	1	1	1	3	1	1	1	1	1		1	2	1	1	1	1	3	2	2	1
22	802599C	56	2	2	2	1	2	3	1	4	4	2	1	1	2		2		3	1	3	2	1	1	2	2	1	1	1	1	1	1	1	1	1	1	1	2	3	2	1	1
23	803271C	42	2	1	1	1	2	2	1	1	1	2	1	1	2		2		3	1	3	2	1	1	2	2	1	1	1	1	1	1	1	1	2		1	1	3	2	1	1
24	812845C	15	1	2	2	1	2	3	1	4	1	2	1	2	2		2		3	1	3	2	1	1	1	3	3	1	1	1	1	2	1	1	1	1	1	2	3	1	2	1
25	402440A	50	2	2	2	1	2	3	1	4	4	2	1	1	2		2		3	1	3	2	1	1	2	3	1	1	1	1	1	1	1	1	1	1	1	2	1	2	2	1
26	826390C	26	2	2	1	1	1	2	1	4	4	1	1	1	2		2		3	1	3	2	1	1	1	2	1	1	1	1	1	2	1	1	1	1	1	2	1	2	2	1
27	618167C	16	1	2	2	1	1	2	1	4	1	2	2		2		2		3	1	3	2	1	1	1	4	1	1	1	1	1	1	1	1	1	1	1	2	1	2	2	1
28	643105C	27	1	2	2	1	1	4	1	1	4	1	1	2	1	2	1	1	2	1	3	2	2	1	1	4	1	1	1	1	1	2	1	3	1	1	2	2	3	2	2	1
29	755507C	22	2	2	2	1	1	4	1	4	4	2	1	1	2		2		3	1	3	2	1	1	1	4	3	1	1	1	1	1	1	3	1	1		3	1		2	1
30	806621C	33	1	2	1	1	1	4	3	4	2	1	1	2	2		2		3	1	3	2	1	1	1	4	3	1	1	1	1	1	2		2		3	1	2	2	2	1
31	821499C	28	1	1	1	1	1	4	1	1	1	1	1	1	2		2		3	1	3	2	1	1	1	4	2	2	2	1	1	2	1	1	1	1	1	2	1	2	2	1
32	829802C	46	2	1	2	1	1	3	1	1	1	1	1	2	2		2		3	1	3	2	1	1	1	3	1	1	1	1	1	1	1	1	1	1		1	3	2	2	1
33	453727O	45	2	1	1	1	1	3	3	4	4	2	1	1	2		2		3	1	3	2	1	1	1	3	3	2	4	1	1	2	1	1	1	1	1	2	1	2	2	1
34	453727O	45	2	2	1	1	1	2	3	4	4	2	1	1	2		2		3	1	3	2	1	1	1	2	3	2	2	1	1	1	1	1	1	1	1	1	3	2	2	1
35	788962C	36	2	1	2	1	1	3	1	1	1	2	1	2	1	1	2		3	1	3	2	1	1	1	4	3	2	2	1	1	2	1	1	1	1	1	2	1	2	1	1
36	786628C	56	2	1	1	1	1	3	2	4	4	2	1	1	2		2		3	1	3	2	1	1	1	3	3	2	4	1	1	1	1	1	1	1		2	1	2	2	1
37	786628C	56	2	2	1	1	1	3	2	4	4	2	1	1	2		2		3	1	3	2	1	1	1	4	3	2	4	1	1	1	1	1	1	1	1	2	1	2	2	1
38	829916C	20	1	1	2	1	1	2	1	4	4	2	1	1	1	1	1	1	1	1	3	2	1	1	1	3	1	1	4	1	1	1	1	1	1	1	1	2	3	2	1	1
39	829916C	20	1	2	2	1	1	4	1	1	1	1	1	1	1	1	1	1	1	1	3	2	2	1	1	4	1	1	1	1	1	2	1	2	1	1	2	2	3	2	2	1
40	823459C	47	1	1	1	1	3	3	1	4	4	2	2		2		2		3	1	3	2	1	1	3	1	1	1	1	1	1	1	1	1	1	1	1	1	3	2	1	1
41	780673C	44	2	2	2	1	1	3	2	4	4	2	1	2	1	1	2		3	1	3	2	1	1	1	3	3	2	4	2	1	2	1	1	1	1	1	2	3	2	1	1
42	171962C	16	2	2	2	1	1	3	1	4	4	2	2		2		2		3	1	3	2	1	1	1	3	1	1	1	1	2		2		2		3	1	3	2	1	2
43	749691C	26	1	2	1	1	1	3	2	4	4	1	1	1	2		2		3	1	3	2	1	1	1	4	3	2	4	1	1	2	1	2	1	1	2	2	3	2	1	1
44	742092C	30	1	1	2	1	1	3	1	1	4	1	1	1	2		2		3	1	3	2	2	1	1	4	1	1	1	1	1	1	1	1	1	1	2	2	2	2	1	1
45	787861C	45	2	1	2	1	1	3	1	1	1	1	1	1	1	1	1	1	1	1	3	2	2	1	1	4	1	1	1	1	1	1	1	1	1	1	1	1	3	2	2	1
46	787861C	45	2	2	2	1	1	3	1	1	1	1	1	1	1	1	1	1	1	1	3	2	1	1	1	4	1	1	1	1	1	1	1	1	1	1	1	1	3	2	2	1
47	854443B	23	2	2	2	1	1	2	3	4	1	2	1		2		2		3	1	3	2	1	1	1	2	3	2	2	1	1	1	2		2		3	1	3	2	1	1
48	798014C	24	1	2	1	1	1	3	4	1	2	2	2		2		2		3	1	3	2	1	1	1	3	3	3	3	1	1	1	1	1	2		3	1	3	2	1	1
49	618733C	18	1	2	1	1	1	1	3	4	4	2	1	1	2		2		3	1	3	2	1	1	1	3	3	2	4	1	1	1	1	1	1	1	1	2	3	1	1	1
50	820257C	15	2	2	1	1	1	4	1	4	4	2	1	1	2		2		3	1	3	2	1	1	1	3	1	1	1	1	1	1	1	1	1	1	1	2	3	2	2	1
51	768103C	30	1	1	2	1	1	4	1	4	4	1	1	2	1	1	1	1	1	1	3	2	2	1	1	4	1	1	1	1	1	2	1	1	1	1	1	2	1	2	2	1
52	768103C	30	1	2	2	1	1	4	1	4	4	1	1	1	1	1	1	1	1	1	3	2	1	1	1	4	1	1	1	1	1	2	1	1	1	1	1	2	1	2	2	1
53	800752C	32	1	1	2	1	1	3	1	1	1	2	1	2	2		2		3	1	3	2	1	1	1	4	3	2	4	1	1	2	1	1	2		1	2	3	2	1	1
54	800752C	32	1	2	2	1	1	3	1	1	1	2	1	2	2		2		3	1	3	2	1	1	1	4	3	2	2	1	1	2	1	1	2		1	2	3	2	1	1
55	673838C	22	2	2	1	1	1	4	3	4	4	2	1	1	2		2		3	1	3	2	1	1	2	4	3	1	1	1	1	2	1	1	1	1	1	1	3	2	1	1
56	837359C	34	2	1	2	1	1	4	1	1	4	1	2		2		2		3	1	3	2	1	1	2	4	2	1	1	1	2		2		1	1	3	1	3	2	1	2
57	675314C	28	1	1	1	1	1	1	3	4	4	2	1	1	2		2		3	1	3	2	1	1	1	1	1	4	4	2	1	1	2		2		3	1	3	2	1	1
58	675314C	28	1	2	1	1	1	3	3	4	4	2	1	1	2		2		3	1	3	2	1	1	1	4	3	4	4	2	1	1	2		2		2	1	3	2	1	1
59	825796C	34	2	2	1	1	1	2	3	4	4	2	1	2	2		2		3	1	3	2	1	1	1	2	3	2	2	1	1	2	1	1	2		3	2	3	2	1	1
60	805415B	27	1	1	2	1	1	3	1	4	4	2	1	1	2		2		3	1	3	2	1	1	1	3	1	1	1	1	1	1	1	1	1	1	1	2	1	2	2	1
61	708695C	18	2	1	2	1	1	2	1	4	4	2	1	1	2		2		3	1	3	1	1	1	1	3	3	1	4	1	1	1	1	1	1	1	1	2	3	1	2	1
62	842917C	26	1	1	1	1	1	3	4	4	4	2	2		2		2		3	1	3	2	1	1	1	3	4	2	2	1	1	1	2		2		3	1	3	2	2	1

serin_datasheet.xls

PRE-OPERATIVE EVALUATION OF CHRONIC SUPPURATIVE OTITS MEDIA

TUBOTYMPANIC DISEASE-OTOMICROSCOPY VERSUS OTOENDOSCOPY:

A COMPARATIVE AND CORRELATIVE STUDY

CONSENT FORM

I Mr / Mrs …………………….. with CMC Hospital number………………… have been explained in my language regarding the study that is being done to evaluate the use of endoscopes in chronic suppurative otitis media, which I have been diagnosed to have. It's been explained to me that this study may help in the betterment of diagnosis and thus treatment of the condition such as the one I have been diagnosed to have. The procedure has been explained to me by the doctor along with the possible complications involved. I give my full consent for the same.

Name and Signature   Date:

SNO	HOS_NO	AGE	SEX	SIDE	ACTIVE	GROUP	ME1	ME2	ME3	ME4	ME5	ME6	ME7	ME7A
1	723912C	38	1	1	2	1	1	4	2	4	4	2	1	1
2	162908B	14	1	1	2	1	1	3	1	4	4	2	1	1
3	740504C	36	1	2	2	1	1	2	1	1	4	2	1	1
4	616788C	28	1	1	1	1	1	3	1	4	4	1	1	1
5	749643C	29	2	1	1	1	1	2	1	4	4	2	1	1
6	682624C	22	1	1	2	1	1	2	1	4	4	2	1	1
7	785834C	43	2	2	2	1	1	2	1	4	4	2	1	1
8	500048C	25	1	1	2	1	1	3	2	4	4	2	1	1
9	511216C	42	2	1	2	1	1	3	1	4	4	2	1	1
10	684727C	50	2	1	1	1	1	3	3	4	4	2	1	1
11	469527C	46	1	2	1	1	1	3	2	1	4	2	1	2
12	223768C	48	1	1	1	1	1	3	1	4	4	2	1	1
13	780298C	17	1	1	2	1	1	1	1	4	4	2	1	1
14	780298C	17	1	2	2	1	1	3	1	1	4	1	1	1
15	728908C	17	2	2	2	1	1	2	1	4	4	2	1	1
16	873989A	33	2	1	1	1	1	2	3	4	4	2	1	1
17	797860C	28	1	2	2	1	1	1	1	4	4	2	1	1
18	799571C	31	1	1	2	1	1	2	1	4	4	2	1	1
19	774671C	48	1	1	1	1	1	2	2	2	4	2	1	1
20	412376C	38	1	2	2	1	1	4	1	1	1	1	1	2
21	865833C	28	2	1	1	1	1	4	2	4	4	2	2	
22	802599C	56	2	2	2	1	2	3	1	4	4	2	1	1
23	803271C	42	2	1	1	1	2	2	1	1	1	2	1	1
24	812845C	15	1	2	2	1	2	3	1	4	1	2	1	2
25	402440A	50	2	2	2	1	2	3	1	4	4	2	1	1
26	826390C	26	2	2	1	1	1	2	1	4	4	1	1	1
27	618167C	16	1	2	2	1	1	2	1	4	1	2	2	
28	643105C	27	1	2	2	1	1	4	1	1	4	1	1	2
29	755507C	22	2	2	2	1	1	4	1	4	4	2	1	1
30	806621C	33	1	2	1	1	1	4	3	4	2	1	1	2
31	821499C	28	1	1	1	1	1	4	1	1	1	1	1	1
32	829802C	46	2	1	2	1	1	3	1	1	1	1	1	2
33	453727O	45	2	1	1	1	1	3	3	4	4	2	1	1
34	453727O	45	2	2	1	1	1	2	3	4	4	2	1	1
35	788962C	36	2	1	2	1	1	3	1	1	1	2	1	2
36	786628C	56	2	1	1	1	1	3	2	4	4	2	1	1
37	786628C	56	2	2	1	1	1	3	2	4	4	2	1	1
38	829916C	20	1	1	2	1	1	2	1	4	4	2	1	1
39	829916C	20	1	2	2	1	1	4	1	1	1	1	1	1
40	823459C	47	1	1	1	1	3	3	1	4	4	2	2	
41	780673C	44	2	2	2	1	1	3	2	4	4	2	1	2
42	171962C	16	2	2	2	1	1	3	1	4	4	2	2	
43	749691C	26	1	2	1	1	1	3	2	4	4	1	1	1
44	742092C	30	1	1	2	1	1	3	1	1	4	1	1	1
45	787861C	45	2	1	2	1	1	3	1	1	1	1	1	1
46	787861C	45	2	2	2	1	1	3	1	1	1	1	1	1
47	854443B	23	2	2	2	1	1	2	3	4	1	2	1	

48	798014C	24	1	2	1	1	1	3	4	1	2	2	2	
49	618733C	18	1	2	1	1	1	1	3	4	4	2	1	1
50	820257C	15	2	2	1	1	1	4	1	4	4	2	1	1
51	768103C	30	1	1	2	1	1	4	1	4	4	1	1	2
52	768103C	30	1	2	2	1	1	4	1	4	4	1	1	1
53	800752C	32	1	1	2	1	1	3	1	1	1	2	1	2
54	800752C	32	1	2	2	1	1	3	1	1	1	2	1	2
55	673838C	22	2	2	1	1	1	4	3	4	4	2	1	1
56	837359C	34	2	1	2	1	1	4	1	1	4	1	2	
57	675314C	28	1	1	1	1	1	1	3	4	4	2	1	1
58	675314C	28	1	2	1	1	1	3	3	4	4	2	1	1
59	825796C	34	2	2	1	1	1	2	3	4	4	2	1	2
60	805415B	27	1	1	2	1	1	3	1	4	4	2	1	1
61	708695C	18	2	1	2	1	1	2	1	4	4	2	1	1
62	842917C	26	1	1	1	1	1	3	4	4	4	2	2	

ME8	ME8A	ME9	ME9A	ME10	ME11	ME12	ME13	ME14	ME15	OTO1	OTO2	OTO3	OTO4	OTO5
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OTO6	OTO7	OTO7A	OTO8	OTO8A	OTO9	OTO9A	OTO10	OTO11	OTO12	OTO13	OTO14	OTO15
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